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Monthly

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SHOOTING YOUR OWN VIDEOS

BUDGET' POWER SUPPLY

GREAT PRIZES TO WIN!

PA COLUMN SPEAKER PROJECT

VINTAGE RESTORATIONS

87-88 INDEX

AUTOSKETCH REVIEW

PA MIKES – THE BASICS

projects • electronics • audio • video • communications • computing • technology

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WELCOME to the re-vamped AEM, our Third Birthday issue. *And* a new low cover price! We are always grateful for reader feedback – positive or negative!. It's all positive feedback, in the final analysis. The message so many of you indicated was – too dear! Right-oh, fixed that! And the inclusion of Elektor – not worth it! The Elektor section did not gain the popularity indicated by our earlier research and we acknowledge that it was not universally approved or tolerated. We never managed to gain the support for pc boards or the occasional specialised components necessary, although some advertisers valiantly gave it a go – and more credit to them for that. In recent times, too, there turned out to be less and less material suitable for publication here, so the section shrank in size – not good value, we're ready to admit. So. We've fixed that, too!

The magazine's too small, although the quality's fine, you said. OK. Here we present more pages and, we trust, the same, if not higher, quality. Get your reading gear around that lot!

As a bonus – check out our Third Birthday contest series with thousands of dollars in prizes to be won – see page 8.

SUBSCRIPTIONS

While our cover price has dropped, a subscription to AEM will remain at the current $42 for one year, $78 for two years; which still represents a worthwhile saving over buying it each month from the newsagent. This is only fair to current subscribers.

A TRIBUTE

An era in Sydney electronics retailing closed with the recent death of Norman Edge. He was Father to Bill Edge, probably best known to readers for his "Bill Edge's Electronic Agencies" kit and component store. Norm, as he was known, belonged to the Edge family, long associated with electronics retailing in Sydney and he was inevitably part of the scene. Norm was associated with son, Bill, in several retail ventures. In the early '70s it was Edge Electrix, then Bill's Electronic Agencies in the late-70s/early-80s. Norm was widely known and well respected, a true "industry identity". Our condolences to his surviving family. Vale Norm Edge.

Roger Harrison
Editor

NOTE OUR NEW ADDRESS & PHONE NUMBER:
1st Floor, 347 Darling St, BALMAIN 2041 NSW
(02)555 1677 – now three lines.

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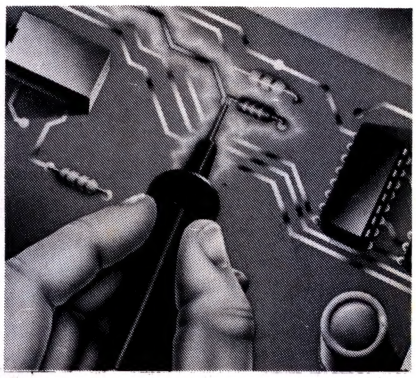
SPECIAL FEATURES

ADVERTISERS INDEX

This index is provided as a service to readers. However, while every effort is spent to make it accurate, the publisher accepts no responsibility for errors or omissions.

PRACTICALITIES

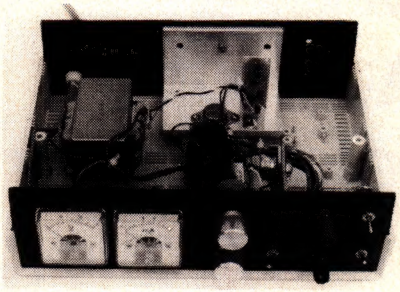
TECHNICALITIES



COMMUNICATIONS

CONSUMER ELECTRONICS

NEXT MONTH



While these articles are currently being prepared for publication, unforeseen circumstances may affect the final contents of the issue.

REGULAR FEATURES

COVER

A static discharge dislodges atoms in a crystal lattice. Illustration from Plastic Systems of the USA, courtesy Componentronics, Adelaide. Design, Val Harrison.

Australia Telescope nears completion

Later this year, CSIRO's new Australia Telescope will turn its eyes to the sky and usher in a new era of astronomy in Australia – and the world.

In the early days of radio astronomy, Australia was among the leaders, and the famous CSIRO radiotelescope near Parkes, NSW was involved in many discoveries. By the 70s it was clear that to retain its standing Australia needed a new, state-of-the-art instrument – hence the Australia Telescope.

The Australia Telescope consists of an array of dishes at widely-dispersed locations. At Narrabri, NSW the installation is made up of a three km "railway" track which carries five independently-controllable dishes.

Three kilometres from the west end of the track is a single dish mounted on a 100m track. Another single dish is located at Siding Springs, NSW. It is planned to integrate the Parkes radiotelescope with the system as well.

The motive behind the geographically-separated array is to construct, by computer modelling, what is effectively a single telescope equivalent in diameter to the separation of the dishes.

The Australia Telescope is a fine example of "Made in Australia". Over 80% of its $50 million budget is being spent at home. Major contracts have been let to local companies, and techniques developed by CSIRO have been transferred to industry.

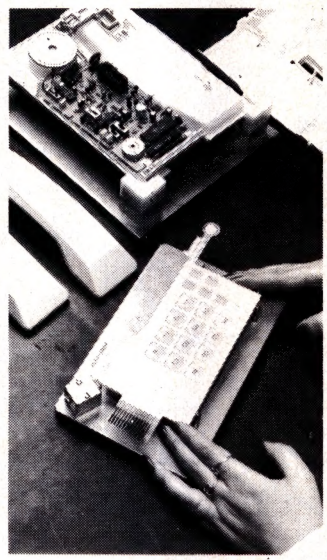
A fair proportion of the work on the Australia Telescope has been done directly by its host institution – the CSIRO Division of Radiophysics – which has considerable expertise in antenna design, digital signal processing, and solid state devices.

The next big step for radio astronomy will be the launching of a space telescope to link up with ground devices such as the Australia Telescope – a prospect not too far in the future.

AWA develops latest Aussie phone

Manufacturing technology developed in Australia will be used to build our latest standard telephone.

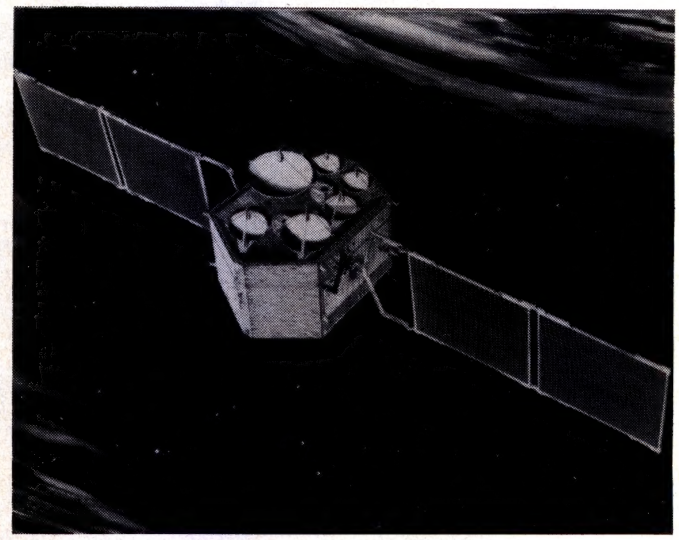
AWA drew on its own unique R&D facilities to design and construct computer-controlled assembly and testing equipment for Telecom's just-released Touchfone 200.



A joint development between Telecom, AWA and Alcatel-STC, the new phone features soft touch dialing, 10 memories, last number redial and PABX compatibility.

The AWA assembly line will produce over 3000 phones per day for the local market with additional capacity for export orders, and should yield $40 million for AWA during the lifespan of the contract.

AWA is exploiting the superior features of the phone by aggressively selling it on the international markets. They have been making telephones for Australians since 1932, and has been involved in the majority of technological advances in local telephone communication.



More Australian hardware into orbit

A digital electronics package built in Australia, the Along Track Scanning Radiometer (ATSR), is now in the UK for final assembly into a spacecraft due to be launched in 1990.

The ATSR is part of the remote sensing ERS-1 earth resources satellite. Among other things, the ATSR equipment will measure the temperature of the ocean surface from space.

British Aerospace Australia Limited (BAeA) engineers developed and manufactured the equipment under clinically clean conditions at their plant at Salisbury, South Australia.

BAeA claim quite rightly that participation in programmes such as ATSR will assist in maximising Australia's involvement in future projects, such as the AUSSAT B series of satellites. This will reduce our dependence and expenditure on overseas technology.

Less accurate, perhaps, is BAeA's claim that the ATSR package is the *first* piece of Australian space hardware to be launched into orbit in the last 25 years. Correspondents may wish to direct their enquiries to **Mr P.A.Hamilton, Manager, Space and Communications Division, British Aerospace Australia, PO Box 180, Salisbury 5108 SA.**

Space Camp

October will see the running of Australia's first space camp, being held by the Sydney Space Association.

The venue will be Naamaroo, a conference centre located in the Lane Cove National Park in northern suburban Sydney. The camp will run for two days. Many space related activities are planned, but the Association says that only those in the 14-90 age group will be allowed to participate.

All accommodation plus meals will be provided at low cost, probably around $25 per day. For further details contact **the Sydney Space Association, PO Box R45, Royal Exchange, Sydney 2000 NSW.**

Ultrasound piezoelectric motor

Matsushita Electric of Osaka has developed an electric motor which functions by ultrasound, rather than conventional electromagnetic coils.

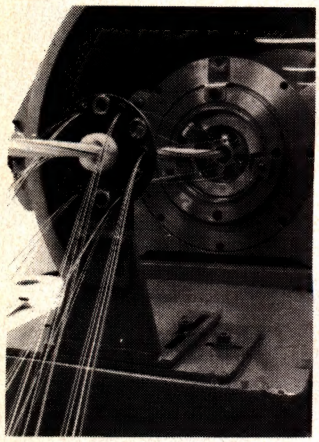
A recent patent application describes the motor as disc-shaped, with a ring of elastic material sitting on top of a matching ring made of a piezoelectric material.

The piezo ring is divided into concentric sections, each of which is fed with electric power of staggered phase, so that the sections are excited in sequence. This sets up standing waves which move round the elastic material to produce the required rotary motion.

Its the length that counts

Austral Standard Cables P/L has set an Australian industry record by producing a continuous 20 km length of optical fibre cable, 8 km longer than the previous best.

The cable contains 14 single-mode optical fibres in continuous unjointed 20 km lengths, and will be used by Telecom Australia in the second stage of the East-West communication trunk route between Perth and Port Augusta.



Single-mode cables have to be joined in the field by highly skilled operators using precise equipment mounted in special temperature-controlled, dust-free vans. The increased single length will therefore provide significant economies in the use of the 565 Mbit cables.

Fundamentals of vision examined by laser

Using extraordinarily short pulses of laser light, scientists have observed the progress of the fastest chemical reaction ever studied – the kind of reaction that triggers vision.

The laser bursts provide a "slow-motion" measurement of a chemical bond twisting 90 degrees in *100 femtoseconds* (100 millionths of a billionth of a second)!

In the light-sensing rod cells of the eye, the same kind of reaction starts a cascade of chemical changes that allow the eye to detect light. This first step is the only one actually triggered by light.

The findings are reported in the May journal SCIENCE by a research team led by Charles V. Shank, director of the Electronic Research Laboratory at AT&T Bell Laboratories, and Richard A. Mathies, professor of chemistry at the University of California.

In the experiment, the scientists used the laser pulses to measure how light was absorbed by the molecule as the rapid reaction proceeded. Changes in the pattern of the light absorbed provide direct evidence of the shape of the molecule and the progress of the reaction.

CORRECTIONS

AEM6504 Power Amp Status Monitor, Aug. '86: The power-on delay does not work as described owing to an error on the pc board and in the circuit as published. Capacitor C5 should be connected between pin 8-9 of IC2 and the +ve supply rail, NOT earth. To correct this, sever the track that earths one end of C5 and run a jumper to pin 14 of IC2. While the prototype functions correctly, this error was in the project as submitted from David Tilbrook.

Practical Filter Design, Part 4, Jan. '88. Two errors popped up in the tables in this part, with miss-placed decimal points. On page 87, Table C 06 20c, line 66 at C4, the value should be 1.0620. On page 90, Table C 09 20, line 85 at C4 should read 5.0900.

Benchbook, Feb. '88, Notes on the AEM3505 packet Modem: In the third paragraph, it is suggested that C5 be changed from 1n5 to 4n7. Actually, you change C2. In the fourth paragraph, it is suggested R18 be changed from 22k to 10k. Change R22 to 10k, not R18.

Project 4512, VZ "Ultra-Graphics Adapter", April '88. On the overlay, 'V' goes to pin 10 of IC2 (the 2764) and 'j' is missing – it goes to a pad just above pin 9 of IC7 (the LS153), presently obscured by the point of the V. On the circuit (p.58), IC3 (the LS161) has pins 3, 6, 7, 10 and 16 shown earthed when they go to +5 V, while pins 4,5 and 8 were omitted – they go to earth.

Project 5507, Mains Checker, May '88. The overlay has two errors. Resistors R8 and R9 are transposed and diode D2 is shown with its band at the wrong end. Amended overlays have been sent to kit suppliers and ammended silk-screen artwork has been sent to pc board manufacturers.

BAe satellite update

British Aerospace (BAe) recently released an artist's impression of their envisaged HOTOL (horizontal take-off and landing) reusable space vehicle, as it would appear taking off from the proposed Cape York Spaceport.

The HOTOL has been designed to launch 7-8 tonne payloads in an easterly equatorial direction, into a 300 km orbit, prior to transfer to the 36 000 km geostationary orbit.

Returning a little closer to the present, the European Telecommunications Satellite Organisation meeting in Paris showed itself to be more than satisfied with the operation of its first generation EUTELSAT I (for which BAe are the prime contractors).

In July this year the ECS 5 satellite will be launched aboard an Ariane 3. When in orbit, it will be named EUTELSAT I-F5, and will provide additional capacity to the network.

EUTELSAT I-F5 will take over the position (13 degrees East) and the functions of the I-F1 satellite, which will be relocated at 16 degrees East. The next generation EUTELSAT II satellite will occupy the 13 degree East position in 1990, allowing service continuity for the next ten years without having to repoint earth station antennas.

There are currently three EUTELSAT I satellites in orbit, providing over 5000 international telephone circuits, twenty-two television transponders, and eight radio programmes.

When EUTELSAT I-F1 is moved to its new orbit, it will be able to progressively meet the current waiting list for thirteen additional television transponders.

For further information on EUTELSAT or the HOTOL project, contact **British Aerospace PLC, Space and Communications Division, PO Box 503, Manly 2095 NSW. (02)977 1194.**

AT&T CEO passes away

James E. Olsen, chairman and chief executive officer of AT&T, died of cancer on April 18th, at his home in Short Hills New Jersey. He was 62.

A former president of both Illinois Bell Telephone Co. and the Indiana Bell Telephone Co., Mr Olsen held a succession of top executive posts at AT&T, beginning in 1977. He became chairman and CEO of AT&T in 1984.

AT&T president Robert E. Allen will continue to direct the company until the board of directors elects a new chairman.

IEEE say OK to AT&T

Bouquets are in order to AT&T Bell Laboratories for their receipt of the Institute of Electrical Engineers (IEEE) 1988 Corporate Innovation Recognition award.

The award cites AT&T specifically for pioneering research in the principles of cellular telecommunications technology and leadership in development of the basic cellular system architecture.

Jolly good show, AT&T!

Fabulous prizes to win in our third birthday contest series!

What a haul! No matter what your interest in electronics, there's got to be several prizes in our great contest series to attract you.

OUR FIRST BIRTHDAY contest series proved extremely popular with readers. In five contests, we gave away six prizes worth over $6000. The contests ran over three issues and we got mountains of mail. We gave ourselves a few headaches judging it!

This year, for our third birthday, we're repeating the exercise – only we've got *more* prizes to give away – worth over $8000! How's that – it's *our* birthday and *we're* giving away the prizes! Eight firms have generously contributed equipment for the prizes: 3M, Dick Smith Electronics, Eagle Electronics, Elmeasco, K.C.C., Kenwood and Philips Scientific & Industrial. There's a total of ten products being given away in seven contest.

The contests this year are constructed in much the same manner as our 1st Birthday contest series. You have to answer a few pertinent questions on the prize, an "interesting" question on the prize's technology or technological background and then write us a little essay. Nothing too difficult there!

Enthusiast, engineer, captain or carpenter – get amongst this lot! You may enter any or all of the contests (hang it, go for broke!), and you may send as many entries as you wish. You can photocopy the contests, rather than cut your magazine, just provided you send an *original* page number of each contest with each entry, cut from an issue in which the particular contest appears. Give yourself more chances!

The prizes

Philips Scientific & Industrial Division donated a PM3050 50 MHz dual-trace oscilloscope for a prize in 1986 – and this year they're donating another! This time around its the upgraded 60 MHz model, PM3055. *And* they're throwing in a pair of 100 MHz x10 attenuator probes. This prize is worth around $2700. Fantastic! This CRO benefits from microprocessor control and has a number of unique features. It's ideal for general service and R&D work and is especially suited to working with video and TV equipment owing to its sophisticated timebase facilities.

Dick Smith Electronics has donated four of their great kits – so, if you're a dyed-in-the-wool enthusiast, you'll go for this. Their prizes are:

The K 6315 Teletext Decoder;
The K 6319 Teletext Tuner;
The K 4003 IR-remote Stereo Preamp;
The K 3437 1 GHz Frequency Counter;

The kits come with full instruction manuals and all parts, including the cases (except for the Teletext tuner, which installs inside the Teletext decoder). No doubt, as an enthusiast, you'll appreciate the utility of the 1 GHz Frequency Counter, while your family will appreciate the Teletext equipment and the IR-Remote Stereo Preamp. That lot should keep your weekends busy for a few months!

The Minnesota Mining and Manufacturing Co., better known as 3M, weighed-in with a static dissipative field service kit. Ideal if you're in servicing, or if you work with products or devices sensitive to static damage. Handy to have around, it could save you heaps, as well as saving heaps of hassles.

Elmeasco, the well-renowned instrument company, has *also* donated an oscilloscope – one from their Aaron range. This is the Model BS-601, worth $890, an ideal unit for general use – fault-finding, signal tracing, servicing, development work, etc. It features a component tester that can check both passives and semiconductors, giving an on-screen display characteristic of the device under test.

For the communications enthusiasts, Kenwood Electronics Australia donated one of their new wideband scanning receivers, the RZ-1. Sophisticated, but simple to use, it's a top performer that comes in such a tiny package it's ideal for mobile use, but acquits itself equally well as a "base" station monitoring receiver. It covers from the AM broadcast band through to 905 MHz, without break, and provides FM as well as AM reception. And we gave it an enthusiastic review in our June issue. This unit is worth over $1000!

Local mains filter manufacturer, K.C.C., has donated one of their top-line LF-4 "Squeeky Clean" Mains Filters. This features *four* filtered outlets and is ideal for keeping mains-borne "hash" from creating interference in communications receivers, etc, and keeping equipment- generated has from getting back down the mains. So, we've teamed it with the Kenwood RZ-1 so you can operate it from the mains, knowing you've eliminated sources of interference there.

And here's something for *everybody*! Eagle Electronics of Adelaide has donated an NEC Microwave Oven. We all have to eat! So, win this and you can spend less time slaving over a hot stove and more time slaving over a hot soldering iron!

Righto! Now, turn through the pages of this issue, seek out the contests and go to it! Who said it? – you've got to be in it to win it!

Rules

The contest is open to all persons normally resident in Australia or New Zealand, with the exception of the members or families of the staff of Australian Electronics Monthly, the printers, Offset Alpine, the companies donating prizes and/or associated companies.

Contestants must enter their names and addresses where indicated on each form. Photostats or clearly written copies will be accepted, but if sending copies you must cut out and include with each entry an original page number and month cut from the bottom of the page of the contest. This contest series is invalid in states where local laws prohibit entries. Entrants must sign the declaration, accompanying each contest, that they have read the above rules and agree to abide by their conditions.

The winning entry will be drawn by the Editor, whose decision is final; no correspondence will be entered into regarding the decision.

Winners will be notified by telegram the day the result is declared and the winner's name and contest results published in the next issue of the magazine in which it's possible to do so.

Send all entries to:

AEM Third Birthday Contests
1st Floor, 347 Darling Street
BALMAIN 2041 NSW.


SONY
PM 3055 50MHz
PHILIPS
PM 3055
PHILIPS

Here's a prize every reader will want!

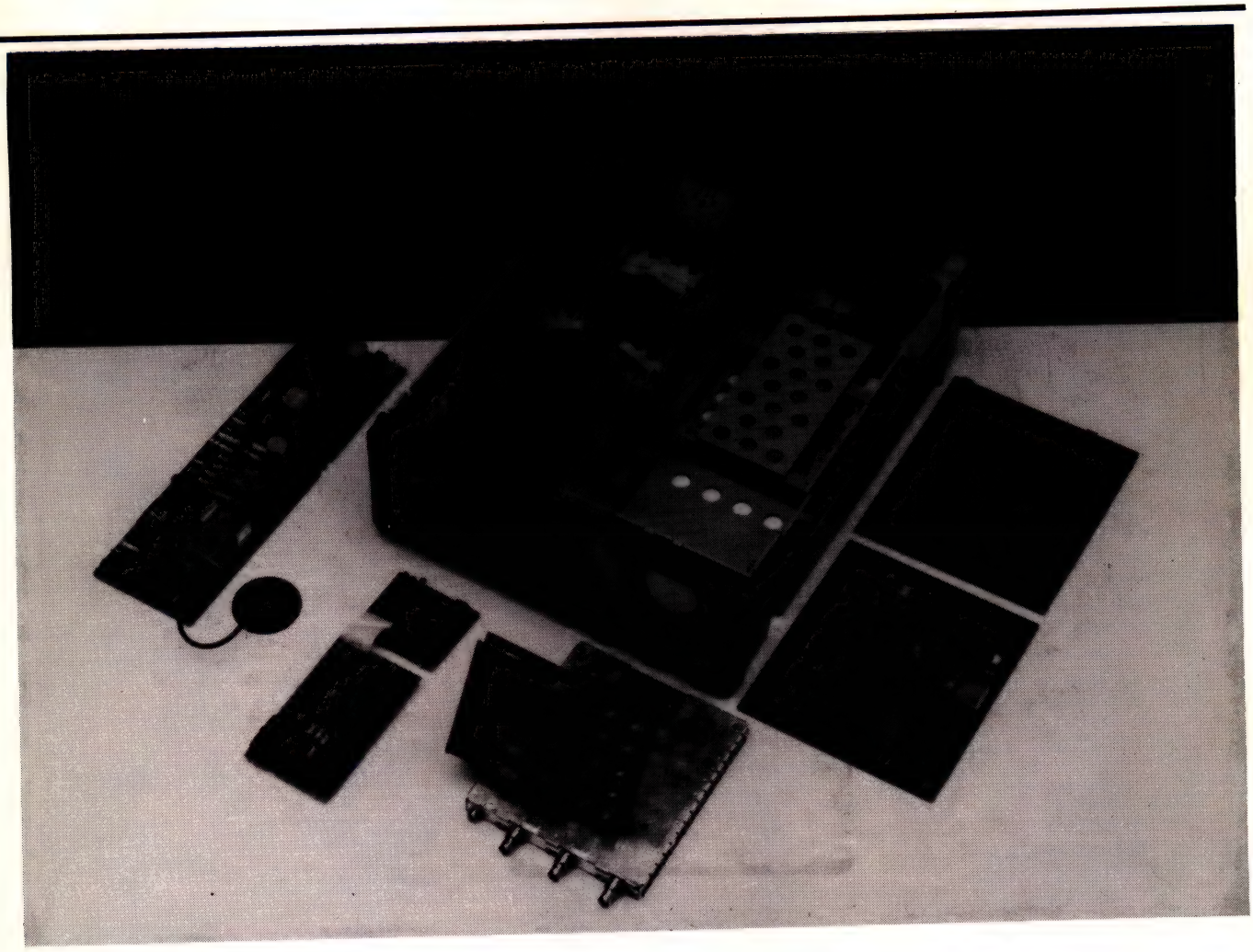
Win this Philips microprocessor-controlled CRO, model PM3055 – it started life as a 50 MHz CRO, but now features a bandwidth of 60 MHz! PLUS – it comes with two x10 100 MHz bandwidth probes!

Here is a fantastic opportunity to own one of the most sophisticated dual-trace CROs available in its class. Engineer or enthusiast – this is a truly great instrument that will give satisfaction for many years. We thought the PM3055 was such a great instrument after we'd reviewed it last year, we got one for use here at the magazine!

You might remember we gave away a PM3055 as a prize in our 1st Birthday Contest series in 1986! Missed your chance then? Well, have another go!

The PM3055 does away with the conventional rot switches used on most CROs to select ranges and fu tions. Instead, selection is by up/down rocker cont and multi-function "softkeys", greatly reducing number of front-panel controls required. And "read" the front panel like a book – left to right, to bottom. It's a natural! Indication of the ranges selec and the status of the various controls is made on a la LCD panel next to the CRT.

The microprocessor-controlled "Autoset" functio



This prize is worth around $2700!

a considerable time-saver in a wide range of applications. This automatically optimises settings for trace amplitude, plus timebase speed and triggering, to bring any connected signal in range and provide a usable display without the need to laboriously adjust manual settings.

The 8 x 10 cm CRT features a parallex-free graticule with variable illumination. Vertical sensitivity is adjustable over the range 2 mV – 10 V per division. Timebase speeds range from an impressive 50 ns right down to 0.5 seconds. The PM8936/09 10:1 probe set is supplied with this superb instrument. Input sensitivity of the probes is selected automatically and shown on the LCD display when they are plugged in. And the probes feature a bandwidth of 100 MHz!

The injection moulded chassis makes this CRO a very sturdy instrument, and service and repair is greatly facilitated by the modular component assemblies.

Prize kindly donated by Philips Scientific & Industrial, PO Box 119, North Ryde 2113 NSW.

1) Prior to the 1930s, cathode ray tubes contained a small proportion of a rare gas. Which gas?

. . . . . .

2) Philips Scientific & Industrial recently moved, what was their *old* address?

. . . . . .

3) When using the Philips PM3055 oscilloscope, hitting the 'Autoset' button will optimise the setting for trace amplitude, timebase speed and triggering. What colour is this magic button?

. . . . . .

In 25 words, or less – why do want this prize?

I have read the rules of the contest and agree to abide by their conditions.

Signature: _____

Name: _____

Address: _____

_____ P/Code: _____

Phone: (___) _____

HAPPY BIRTHDAY, AEM... from all at DICK SMITH ELECTRONICS

WINTER: A GREAT TIME TO BUILD A KIT AND $AVE!

AEM's new Mini Mixer

Fantastic! A 4 input audio mixer for the amateur with specs good enough for the pro! Use it for mixing various audio sources - mics, tapes, guitars, organs, etc etc. Easy to build, easy on the pocket! Cat K-3039

ONLY **$29.95**

AMPLIFIER MODULES

Amplifier Modules

High performing modules for use in PA, band amps, even good enough for hi fi use! And they're $$ cheaper than last year!

60 Watt Mosfet

Easy to build module with everything on one pcb. Easy to get going - and easy on the ear! Easy kit from AEM. CatK-3441

LAST YEAR: $87.95
THIS MONTH: **$49.95**

120 Watt Mosfet

Similar to amp at left, but this one packs a massive 120 watts of muscle. Just add an appropriate power supply and GO! Cat K-3443

LAST YEAR: $109
THIS MONTH: **$59.95**

It's Alarming!

Light fingered louts are lifting lots of lovely loot. Stop 'em in their tracks with these alarm kits!

Car Alarm

The deluxe job from EA. Everything you could want to protect your car - and then some! Cat K-3252

WAS $89 NOW **$79.95**

Home Alarm

While you're out driving, what about your castle? Protect your posessions with the home alarm. Easily the equal of most "pro" alarms - but you do-it-yourself! Cat K-3424

SAVE $20!
WAS $169 NOW **$149**

Motion Detector

Use it as an alarm sensor - or just for fun. Latest technology IC actually senses movement. Easy to build - great school project too. Cat K-2721

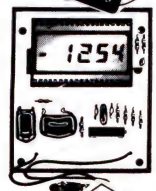
WAS $29.95 NOW **$27.95**

$10 OFF TEST GEAR MODULES

LCD Panel Meter

Versatile meter for huge range of projects. Make it read what you want it to! Cat K-3450

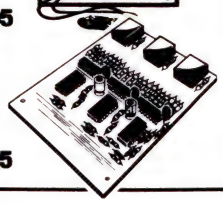
WAS $49.95 NOW **$39.95**



Counter Module

3 digit counter with driving circuitry to do . . . whatever! Comprehensive manual included. Cat K-3451

WAS $29.95 NOW **$19.95**



VCR KITS

No, we're not selling kits to make VCR's! (Hey! That's a good idea. R&D — get cracking . . .) These kits will add enjoyment to your videoing.

Sound Processor

Most VCR's have sound that's, well, pretty pedestrian. This great kit from EA allows you total control over your VCR sound. Cat K-3422

LAST YEAR: $59.95
THIS MONTH **$39.95**

Dynamic Noise Reduction

Proprietary chip enables you to really improve the S/N ratio, get rid of that annoying noise most VCR's tend to leave behind. As seen in EA. Cat K-3423

LAST YEAR: $99
THIS MONTH: **$39.95**

Video Enhancer

2nd generation tapes often leave a lot to the imagination! Fix up the detail left behind with the video enhancer kit. And save while you're doing it! Cat K-3463

WAS $42.95 NOW ONLY **$39.95**

TV Pattern Generator

What's this got to do with VCR's? Not much - but if TV repair is your game, then this one's for you. Dot, crosshatch and blank raster. And yes, you save! Cat K-3472

WAS $34.95
NOW ONLY **$29.95**

AMATEUR RADIO KITS

HF Transceiver Kit

A beauty for the novice - or the old timer who wants to "keep his hand in". Operates over 500kHz segment of 80m band as supplied, can be modified for other bands. Cat K-6330

WAS $399
THIS MONTH: **$369.95**

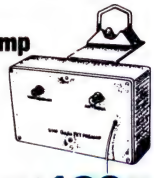
Upgrade Kits: $20 OFF!

40 metre upgrade kit for above transceiver. Cat K-6332
WAS $39.95 NOW **$19.95**

10 metre upgrade kit for above transceiver. Cat K-6337
WAS 39.95 NOW **$19.95**

GaAsFET Masthead Preamp for 70cm reduced, too

13dB gain with around 1.5dB noise: nice! Complete kit includes all mounting hardware for mast top. Pull in signals you didn't know existed! Cat K-6309



WAS $129 NOW **$109.95**

$20 OFF 100W 2m linear

Cut through the noise - and get at least 100W out with 10W drive! 13.8V DC operated - so it's just as much at home mobile! Cat K-6313

WAS $299 NOW **$279**

RF Attenuator

Too MUCH signal your problem? RF Attenuator will solve it. And you'll solve the $10 saving. Cat K-6323

WAS $79.95 NOW **$69.95**

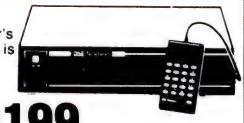
70cm Preamp way down!

Bipolar preamp ideal for whole 70cm band, small enough to fit inside transceiver case. Good value normally, GREAT value now! Cat K-6306

WAS $21.95 NOW **$12.95**

Save $70 on the Teletext Decoder

Yes! A big $70 off last year's already low price. Teletext is free - all you need is a decoder to get it! Works through virtually any VCR. Cat K-6315



LAST YEAR: $269 NOW ONLY **$199**

UHF to VHF Downconverter

Old telly? No UHF, huh? But you want to watch SBS or a local area translator? You can with this downconverter! Cat K-3236

WAS $76.50 NOW **$69.95**

Teletext Tuner

Intended for the above kit when you don't want to run it through your VCR. Also real handy if you don't own a VCR! Pre-build module means the hard bit's all done! Cat K-6319

LAST YEAR: $99.95 NOW ONLY **$59.95**

Infra-Red Remote

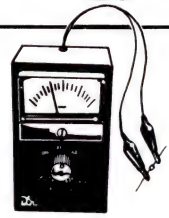
Add I/R Control to your teletext decoder. Why trip over wires? Cat K-3425

LAST YEAR: $41.95
NOW ONLY **$29.95**

TEST IT!

Zener Tester

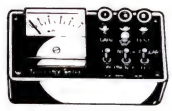
Great for when the value's rubbed off - or your eyesight can't distinguish those damn tiny numbers! Cat K-3051



WAS $29.95 NOW **$26.95**

Transistor Tester

NPN, PNP, diodes, FETs, PUTs: Check them all for gain, leakage, shorts. A must for the junk box! Cat K-3052



WAS $26.95 NOW **$24.95**

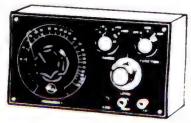
RLC Bridge

What about all the passive components? This will check them for you - why throw them out just 'cause you can't read 'em? Cat K-3468

WAS $59.95 NOW **$49.95**

Audio Oscillator

Sine & Square waves from 15Hz to 150kHz - indispensable for the test bench, the repair bench or the development bench. Cat K-3469



WAS $49.95 NOW **$44.95**

Power!

That's what you get when your build the VK Power-master. 13.8V out at up to 14A (depends on transformer you use). Short form kit - does not include transformer. Cat K-3448

WAS $129.95 NOW **$119.95**

Transformer to suit:

M-2010 (gives 14A cont) $64.95
M-2000 (gives 6A cont) $34.95

Need a Keypad?

Put together this one! For all situations requiring digital entry, it's superb. And look at the ridiculously low price! Cat K-3600

COMPLETE WITH CIRCUIT **$3.25**

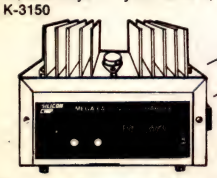
NEW KITS THIS MONTH!

SC

Discolight

$165

Move over, Musicolour: the Disco Light is here! An incredible array of spectacular lighting functions is at your fingertips with this new design from Silicon Chip. Features 4 channels with sound to light, chasing, beat chasing, strobing, beat strobing, reverse, forward, up, down, sideways . . . you name it, your lights will do it! Cat K-3150



SC

Megafast Nicad Charger

$45

If you race cars or boats, you'll know what a hassle charging the 7.2V NiCad is. And you'll probably also know (to your cost) that most chargers aren't worth a cup of cold tea! Silicon Chip's new 7.2V NiCad Charger has two different cut-off methods to prevent overcharge - but will still charge a dead flat NiCad in around 15 to 20 minutes. Beaudy! Cat K-3477

Speaker Protector

That "thump" you get when you turn your amplifier on is more than annoying: it's dangerous! You could end up blowing the cones from your speakers - and possibly damaging the amp as well. Protect your investment with this kit: it's easy to build, and stops that massive overload hitting your speakers. You'll find it in this month's Electronics Australia, Cat K-4008

$37.95 EA

AEM

Tilt Alarm

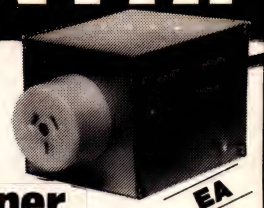
$11.95

Talk about novel: a go-anywhere alarm which will sound when it's tilted. Think of the applications: theft alarms for bikes, golf clubs, . . . anything; even stops people tilting back on chairs! New this month from Australian Electronics Monthly. Cat K-3248

Strobo Tuner

Tuning forks are passé! With this new tuning aid from Electronics Australia you'll be able to accurately and professionally tune musical intruments in seconds. It's fully self contained and is quite an easy kit to build. If you're into music - get into this! Cat K-3550

$54.95 EA



EA

Line Filter/ Conditioner

Here's one for the computer buffs, especially (but it also suits hi-fi & countless other applications) Elcom is supposed to sell you 240V, 50Hz. Unfortunately, they also give you all sorts of spikes, spruigles and shrdlupp on the line (not to mention the clicks and plops you make yourself!). Clean up dirty power lines with this new line filter/condition from Electronics Australia. Fred Nile would be proud of it! Cat K-3080

$39.95

Want to build a Crystal Set?

Like the one in this month's EA? Sorry - we cannot supply that kit (the tuning capacitor is almost impossible to obtain!) But we can help you with a kit for a crystal set! Did you know that in Fun Way Into Electronics there's a crystal set to build - along with 19 other great projects - including the famous Beer Powered Radio! Get into Electronics the Fun Way!

Fun Way Into Electronics Gift Box (Fun Way Vol 1 plus 20 projects to build). Cat K-2605

$26.95

MORE KIT BARGAINS . . HURRY . . LIMITED STOCKS . . .

EM's IR Remote Switch

Save $10 Controls ually any 240V device with off control. Just the shot those cold winter nights: n the telly off without ting out of bed! Cat K-3428

~~$69.95~~ NOW ONLY $59.95

Share Transmitter: Save $6

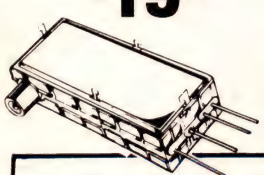
t in case you lose one (or ive someone else control !) Same transmitter as in ove kit. Cat K-3429

~~WAS $15.95~~ NOW $9.95

When is a Kit not a Kit?

When it's a modulator kit. RF modulator is pre-built and tested, ready to add to that project you've been waiting to build. Cat K-6043

$19.95

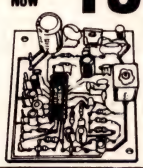


AM Stereo — Cheep!

Why buy a new tuner when you can add this AM stereo decoder to your present tuner and get full AM stereo? And look at the saving . . .

Cat K-3415

~~WAS $26.95~~ NOW $19.95



Nothing negative about this one! Near ½ Price Neg Ion Generator

What a saving! And what a kit! Build your own negative ion generator: find out for yourself if the fantastic claims are true! Price includes safe, low voltage plug - pack. Cat K-3333

~~WAS $49~~ NOW $24.95

Check your Microwave!

Is it safe? Does it leak dangerous microwaves? This great little kittle tellya! Cat K-3095

~~WAS $17.45~~ NOW JUST $12.95

Why build a radio?

Just for the fun of it! Build yourself a great performing little AM Headphone Radio. And this month you'll save $2.00! Cat K-2720

~~WAS $19.95~~ NOW $17.95

TV Cro Adaptor

Turn that old b&w (or colour if you're affluent) TV into a great audio oscilloscope with this nifty kit. Up to 300kHz bandwidth - so its great for audio! Cat K-3060

SAVE $5! $34.95

We'll LED you make savings!

LED Tacho: $7 OFF!

Build your own tacho: LED's show instant engine speed. Cat K-3240

~~WAS $26.95~~ NOW $19.95

LED Level Meter

Add this to your hi fi for a mini lightshow! It's useful, too - peak level display can warn of danger! Cat K-3370

~~WAS $18.95~~ NOW $16.95

DSX PRESS — DICK SMITH ELECTRONICS EXPRESS ORDER SERVICE

STD FREE (008) 22 6610

(SYDNEY AREA (02) CALL 888 2105)

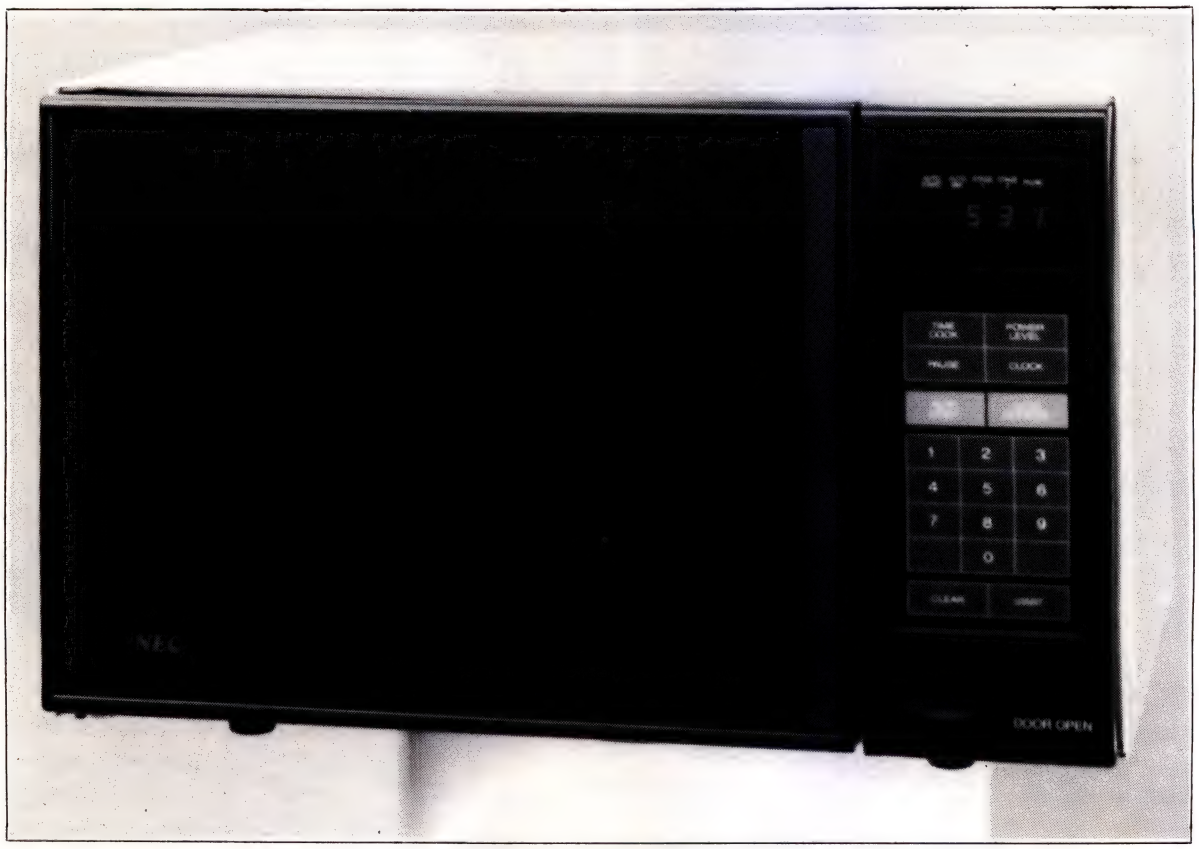
NOW AVAILABLE AT ALL STORES — OR CALL TOLL FREE: (008) 22 6610 FOR HOME DELIVERY!

DICK SMITH ELECTRONICS

3RD BIRTHDAY CONTEST No.2.

Slave over a hot soldering iron, not a hot stove!

Win this NEC Microwave Oven!



You would, of course, prefer to spend more time on interesting pursuits than at functional activities such as making meals. Unless making meals is a more interesting pursuit, that is!

Well, Adelaide electronics retailer, Eagle Electronics, has presented you with this dilemma – er, fabulous prize, a top-line microwave oven by NEC. Win this and you'll be able to whip up a quick snack so you can return to that project on the bench, or whatever.

This NEC microwave features all the latest control tricks with it's microprocessor operated control panel. And it's a cinch to operate!

Of course, if you don't want it in the workshop, you could always endear yourself for ever to the rest of the household and donate it to the kitchen!

---

1) Heart of the microwave oven is the "magnetron", a high power 2.5 GHz oscillator. Name the two men who developed the "cavity magnetron"?

. . . . . .

2) What is NEC's "company slogan"?

. . . . . .

3) Eagle Electronics has an associated company in the kit business. What's its name?

. . . . . .

In 25 words or less, describe the first meal you'd like to cook in this NEC microwave oven.

I have read the rules of the contest and agree to abide by their conditions.

Signature: _____

Name: _____

Address: _____

_____ P/Code: _____

Phone: (___) _____

NOTICEBOARD

This special page is for the benefit of readers, to help you make better use of your magazine.

Please check this page **every month** as notices **will** be changed often.

WHERE DO YOU GET IT?

Where do you buy the parts and PCBs for the projects? Every issue has a column called "Retail Roundup", in which you will find the "Project Buyers Guide", usually in a box on the page. This provides a guide to where you might buy your needs for the projects featured in that particular issue.

OOPS!

Yes, we are human and we make mistakes. Errors can arise for all sorts of reasons, but we make every effort to keep them to a minimum. In the past, we've generally published Notes & Errata in the News Review pages at the front of the magazine. From now on, look for them here.

GOT OUR RIGHT ADDRESS?

Most important! It has become obvious to us that a lot of readers are still addressing mail to our old addresses (there are three variations) so will you make sure that you have our new address, phone and fax numbers?

AEM
1st Floor, 347 Darling Street,
BALMAIN 2041 NSW.
Ph. (02)555 1677. Fax: (02)555 1440

Special Offers

We pride ourselves in making available to you special opportunities to purchase interesting products at a special price.

Mostly, we act as a clearing house for orders and have to contend with the usual SNAFU's. Fortunately, they're not too prevalent. If you have a problem with an order, kindly write or call and give us your full name address and ordering details, and most importantly, your phone number. We'll do our level best to sort it out and inform you.

Back Issues

If you are looking for a particular back issue, it's simple, just write to us: **AEM, 1st Floor, 347 Darling Street, Balmain 2041 NSW** and state which issue(s) you need, enclosing a cheque or money order for $4 for each back issue.

It is wise to state which particular article or project interests you in the issue(s) you have specified, because if we don't have the issue in stock, we can send you a photostat of your specified article or project. We are unable to process back issues by credit card, unfortunately, unless the order is above $10.

PROJECT LEVELS

In general, with our projects we include a panel indicating the "level" required for successful construction. This is included only as a guide, the three levels we show being: "beginners",."intermediate" or

LEVEL: We rate this construction project as suitable for:

EXPERIENCED

constructors who have successfully assembled a variety of projects of differing complexities.

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Technical Enquiries

Please, only after 4.30 pm EAST.

If you were a fly on the wall in our office you would notice that the people who answer these enquiries do not sit all day with baited breath awaiting your call. In actual fact they are crucial members of our team and are expected to do 'some' other work during 'normal' business hours. So please, while we are happy to answer your technical enquiries we also have a magazine to get out. After all, isn't that how you found us in the first place?

Australian MODEMS Monthly?

Dear Sir,

I have been buying your magazine "off the shelf" for quite some time now. This has given me an advantage over subscribers in that any issues I find uninteresting, I don't have to buy.

Lately, however, I find I have been buying your magazine even less frequently then usual. Since the few I do buy are usually of quite high quality, I'm writing to explain why I consider so many issues to be virtually hopeless. Basically then: I DON'T OWN A MODEM.

Furthermore, I don't want a modem. Admittedly, I may need one some day, but even then I'd probably buy one with a warranty, rather than spend days building, testing, fault-finding etc, etc.

So every time I see glossy front page photos of modems, or read of the "Star Project" being another modem, I (barely) stifle a yawn as I replace the issue on the shelf. I wonder how many other hobbyists don't own a computer, or already own a modem, and are as bored as I am?

Come to think of it, how many satellite decoder projects will never be built, for lack of the money to buy the kind of HF/VHF AM/SSB/FM receiver such a project needs at the front end? (Now THAT would be an interesting project...)

So please, enough already of modems! Move on to something else to get out of the rut you're currently in – or change the name of your magazine to "Australian MODEMS Monthly".

Mr A. Campbell
Newport, Vic.

*Why didn't **we** think of that?! The name has something of a **ring** to it!*

Enough of the puns. Well, maybe you're not interested in modems – but lots of other readers/constructors are. The six modems we've presented in the past three years have all been quite different, with differing features and functions, of differing prices and differing appeal – ranging from the Super Simple Modem to the current SUPERbis Modem.

But, if to you, a modem is a modem is a modem, and computers are anathema – then we offer no apologies. We can't hope to be everything to everybody every month!

*We aren't planning **another** modem – at this stage though, you'll be pleased to note, and yes, we are "moving on to something else."*

On the subject of satellite decoder projects and lack of a suitable receiver, clearly, you missed our February issue this year. In that issue John Day VK3ZJF described the AEM3520 VHF Weather Satellite Receiver, for which a kit can be bought for around $130. Interested? Perhaps you didn't look too closely at the front cover (where the receiver was mentioned) because we had a picture of the Supercomputer project on it.

Back issues of February '88 are sold out (very popular!), but photostats of the article may be obtained for $4.00 post free.

To "get out of the rut", we've planned more 3520-type projects, amongst other things. Time for a subscription, perhaps?

Roger Harrison

Speech synthesiser for the C64

Dear Sir,

I am currently constructing the "Low Cost Speech Synthesiser", project number 4505, which appeared in the *February 1986* issue of AEM.

I own a Commodore C64, with which I intend to use the project. The article mentions that software for other computers (other than the Microbee) will be supplied "in coming issues." I have not been making projects for very long, so I have not been following your magazine. Could you please tell me if software for the C64 has been published?

If it has not appeared yet, could you tell me when the software will be published? This would be greatly appreciated.

C. Mooney,
Hurstville, NSW.

Details on adapting the software to the Commodore 64 appeared in the "Commodore Codex" column on page 38 of the July '86 issue.

RADFAX timing for fast clones

Dear Roger,

I have recently built a Listening Post for a friend and have found a couple of problems. The kit came from Eagle Electronics with a photocopy of the original article.

The circuit overlay shows the supply positive going to ground and vice versa. I only noticed this when I plugged it into the computer, when it sank the 5 V rail and cooked the XR chip. Perhaps there was a correction in a later article, but with the renewed interest due to Michael Delahunty's IBM software, it could be time for a reminder. The circuit overlay also shows the centre pin of the audio connector going to ground.

Once the hardware was fixed it worked brilliantly, but I had a lot of trouble with the timing loops in the software. The computer is a common non-turbo Taiwanese clone. I tried lowering the value of *delay* and eventually started to see a recognisable picture with a value of about 10 less than the default.

In *realign* mode the picture was OK, but in *view* mode it seemed to have a double image. I thought that I had adjusted *delay* to a harmonic, and went lower with no success.

Eventually I got good results with a *delay* of 107 and a *finetune* of 646. Perhaps this information will be of benefit to others, as the instructions imply only small changes to *delay* are necessary.

Norton's "SYSINFO" utility revealed an NEC V20 CPU, and a computing index relative to the IBM PC of 1.8.

Garry Boyce,
Crafers, SA.

Most errata concerning the errors on the wiring diagram for the AEM3500 Listening Post were published in the August '85 issue, on page 100. Ammended pages for photocopied kit instructions were subsequently circulated to retailers, although by all reports many seem to have lost these in recent times! We have re-sent the details now.

To recap, the leads shown coming from the pc board were transposed in the following cases: the +5 V input and GND, anode and cathode of the LED, active and ground of the RCA connector, "G" and "H" to SW1.

Hum in the Ultra-Fidelity Preamp

Dear Sir,

Some time ago I built the "Ultra Fidelity" Preamplifier (AEM Oct-Dec '85). I have been using it with my Denon DRM-44 cassette deck, achieving excellent results. Just recently I purchased a Rega turntable with moving coil cartridge, and although the phono section works well there is a fair amount of hum present. This hum disappears when the monitor switch is flicked from "source" to "tape".

Since I've checked the turntable with other preamps and found it to be flawless, I assume the problem is with the phono section. Having checked the boards and wiring and found them to be correct as per the articles, I was wondering if there was anything that I had missed – errata or addenda-wise, that is.

Failing this, any suggestions or ideas that you may be able to supply in

regards to this hum problem would be greatly appreciated. I look forward to completing many more of your excellent projects.

Lloyd Buckle,
Brompton, SA.

Addenda and errata on the 6010 preamp were published on page 76 of the Jan. '86 issue. However, what you'll find there won't affect your problem.

Without knowing exactly what your setup is, I can only suggest some general tests to find the source of the problem.

Firstly, check for a "ground loop" between your turntable and the preamp and/or power amp. The turntable signal leads should provide the only "signal ground" for the cartridge, via the preamp RCA input sockets. Check that these are not shorting to the chassis where they pass through the preamp cabinet's rear skirt. There should be no dc path between the preamp signal ground and the preamp's chassis, although there is a capacitor linking the two.

Try unplugging the turntable signal leads at the preamp and see if the hum drops. If it does, try unplugging the turntable's mains lead and see if that causes the hum to disappear. If so, it's likely you've got a hum loop and you'll need to figure out a way to separate the signal earth (from the cartridge) and the power earth (via the mains lead).

If you unplug the turntable leads at the preamp and the hum remains, it's likely the hum is being picked up within the preamp's chassis, most probably through an inadvertent "extra" earth. The chassis of your power amp and the chassis of your preamp should be directly linked (via the DIN signal/supply connectors and interconnecting cable), but the signal grounds run separately via the shield of the preamp-power amp signal cable. The signal earths and the chassis connections are only linked at one spot, within the power amp.

Weather FAX on a Kaypro 2

Dear Sir,

I read with interest your article on the "Listening Post" in AEM July '85 and the article in April '88 on the VHF weather satellite ground station. As a cruising yachtsman I am extremely interested in being able to print the weather maps depicted in the articles from both HF and VHF.

I am an electronics person (radio communications) rather than a computer person – although I do use a computer. The equipment I have is a Yaesu FRG8800 receiver fitted with the internal VHF converter and a Kaypro 2 computer with a MICROEDP printer.

I would be very much obliged if you could answer the following questions for me:

1. Do I need to have two different decoders, i.e: the AEM3500 Listening Post and the AEM3503, or is either one suitable for both HF and VHF?

2. Do you have suitable software for use with my Kaypro 2 computer?

3. Have you described, or plan to describe, or is there otherwise available, a dedicated microprocessor to drive the printer direct, without the use of the computer?

Thanking you in anticipation.

S. Watson
Wanneroo, WA.

Thanks for your interest. In answer to Question 1, the AEM3500 was designed to decode the FAX transmissions of weather maps broadcast on the HF bands by stations such as the Bureau of Meteorology's AXM and AXI while the AEM3503 (described in the July '86 issue) was designed to decode the FAX transmissions on VHF from the polar-orbiting weather satellites, which employs somewhat differing transmission standards.

For the Kaypro 2, running under CP/M, you'll have to write your own software. A "commented listing" of the original Microbee program is available for $2.50, post free.

Dedicated FAX decoders are available, complete with receiver; just add dot matrix printer and hey presty!, instant weather FAX maps. Magna-Tech in Sydney distribute one, but be prepared for a hefty price tag. We are considering doing a microprocessor-based "stand-alone" FAX/RTTY/Morse decoder, which is a relatively simple task hardware-wise. It's the software development necessary that's the daunting bit!

Roger Harrison

Novix on the C64

Dear Sir,

I have been reading with interest over the last few months your magazine's series of features on the Novix 4016-based Supercomputer.

I am writing to enquire about the suitability of an ordinary Commodore 64 as the host for this project. I intend to upgrade in the near future, and the kit offered by Maestro would be an interesting project.

Any advice on the topic would be greatly appreciated.

M.Smith
Lower Plenty, Vic.

*You can use **any** computer which has a serial interface fitted. With regard to your C64, you really need a disk drive (if you haven't already got one), for storing programs you write, and we would*

• to page 114. ▷

Static — its haunts and habits

David Glenmere

Static electricity is ever-present in our everyday environment and activities – a fact too few people are conscious of. The fields alone generated by static charge on your body, or objects around you, can damage electronic components, quite insidiously. In this article, our correspondent – a specialist in the field – outlines just how and where static causes problems and how its effects can be controlled and minimised in everyday electronic work.

TEN YEARS AGO only a small percentage of people in Australia would have come across the term ESD. The control of static electricity in electronics was mostly confined to the larger computer companies and the military. Today static damage can affect any industry that uses ICs. The computer industry is often at the forefront of control measures – hardly surprising since they use the newer technologies, but things happen very quickly in electronics. After all, how much CMOS was used outside the computer industry ten years ago, or even five years ago? Component technology advances at a phenomenal rate and each new generation is more sensitive to 'static' than its predecessor.

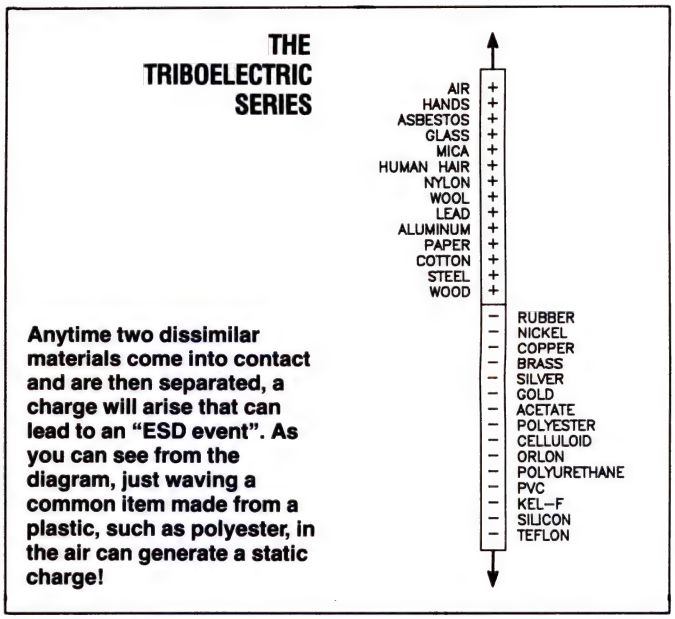
The term "ESD" was once used to describe *Electrostatic Discharge* but nowadays the term commonly applies to *Electrostatic Damage*, after all a very large proportion of todays components are Field Effect types and FET's can be damaged by voltage fields *overstressing* the oxide layers.

Classes of static damage

Static damage to components can be divided into two classes, *catastrophic* and *degradation*. Catastrophic failure is benevolent – the device just stops working and is easy to locate. Degradation however, is a far more serious problem since degraded components will generally not show on testing but will at some stage in the future start to give problems – unfortunately, that stage is generally after manufacture or repair when the customer is using the product!

Catastrophic failure accounts for 5 to 10% of damage, and degradation 90 to 95%! It does not matter what the end product is, it is always cheaper to repair a fault at the manufacturing stage. Degraded components are disasters waiting to happen, they may not actually fail in the field but instead create intermittent problems which are even more difficult to detect and the product then goes back and forth between the customer and the service department to the frustration of both. Small wonder that some companies consider staff that disobey static control measures as being wilfully negligent and treat them accordingly.

Repairing a fault when the customer has found the problem is not only more expensive it also causes the customer to lose confidence as the failure of your equipment may cost him money! This can be expensive to you when the customer decides not to re-order your product.



Generation

Since static electricity causes so many problems we had better look at how it is generated, how it causes problems and how we can control it.

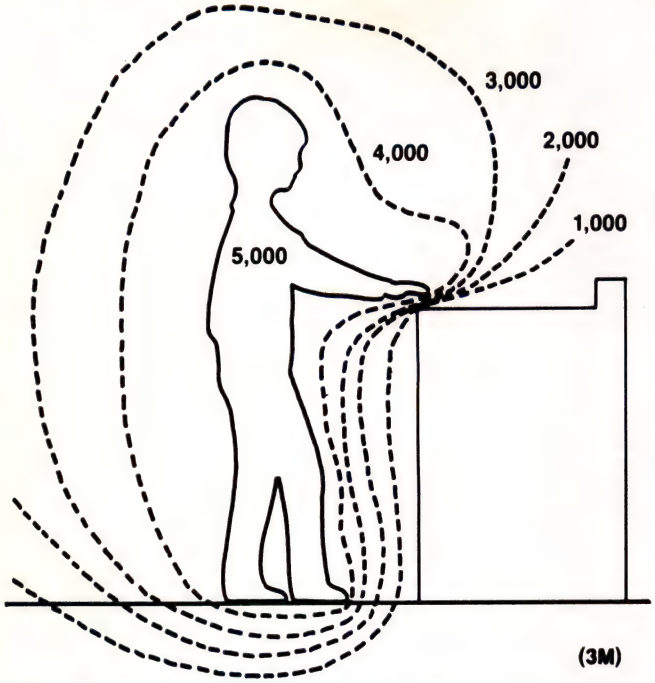
Static electricity can be generated in many ways. However,

Reported Susceptibility Ranges of Various Devices Exposed to Electrostatic Discharge From a Person or Electronic Equivalent

Device Type	Range of ESD Susceptibility (Volts)
VMOS	30 -1,800
MOSFET	100 - 200
GaAsFET	100 - 300
EPROM*	100
JFET	140 -7,000
SAW	150 - 500
OP-AMP	190 -2,500
CMOS	250 -3,000
SCHOTTKY DIODES	300 -2,500
FILM RESISTORS (THICK, THIN)	300 -3,000
BIPOLAR TRANSISTORS	380 -7,000
ECL	500* -1,500
SCR	680 -1,000
SCHOTTKY TTL	1,000 -2,500

*PC board level

David Glenmere is a static analyst who works independently in the industry and specialises in documentation, programme implementation and training. He's chairman of the Australian Electrostatic Discharge Overstress Association and can be contacted on phone (02)680 2049, FAX (02)750 5224.



"Typical" electric field surrounding a statically charged person. Note the concentration of the field lines around the fingertips!

the greater proportion of charges originate from *triboelectric* charge generation – often referred to as frictional charging. This term basically states that anytime two materials are in contact and are separated a charge will be generated. The purist might argue that the term should include 'dissimilar' materials, however this is open for discussion as many insulator materials will quite easily generate a charge when separated from themselves.

The magnitude of the charge is determined by the materials themselves, the intimacy of contact and the speed and method of separation and the process is modified by humidity. The triboelectric series (see the accompanying chart) gives us a hierarchical order of whether a material will become positively or negatively charged. We could imply that some materials are positive in that they attract electrons and thus become negatively charged whereas some materials will easily give up electrons. The true reasons for this method of charging are still the subject of much discussion and research. However, the fact is that it happens!

Every electron moving from one material to another will create a negative charge and leave a positive charge behind. Sometimes these charges are very small and need metering equipment to detect – at other times they are often large enough to be seen or felt by us.

ANTISTATIC?

The word 'Antistatic' is consistently misused as a generic term for all static control products – it should be used to describe a material that 'minimises' triboelectric charging – not controls it. In the past, the 'antistat' properties of a material were described by its resistivity range. This is no longer considered appropriate. In fact, the U.S. EIA no longer includes 'antistatic' in its material resistivity range because "the antistatic property of a material is not necessarily correlated with it's resistivity." Most antistat treatments are chemicals (agents), either added to a product at the manufacturing stage or sprayed on objects (topical).

The former tends to be permanent, while the latter is temporary. At best, when first applied they offer some protection but will eventually wear off or degrade with time and humidity. Their effectiveness is difficult to measure and their performance degrades immediately they are applied. At best, they minimise charge generation. At worst, they do little to an already existing charge and offer a false sense of security. 'Antistatic' products can be used in certain areas, but with caution – especially pink poly bags and bubble wrap as they provide little or no shielding. The only universally accepted antistatic product is the inner layer of a shielding bag.

The effect on components

Once charged, an object has the ability to discharge to another object that is at a lower potential. Charged objects also exhibit voltage fields – the very factor that makes a FET function. The last thing a sensitive device needs is a miniature bolt of lightning injected into it or a FET being subjected to a voltage field greater than the oxide layer(s) can withstand – no actual discharge required!. If the discharge or voltage field is greater than the 'withstand' capabilities of the device then some damage is going to occur, either in the form of destruction or alteration (degradation) to its operating characteristics.

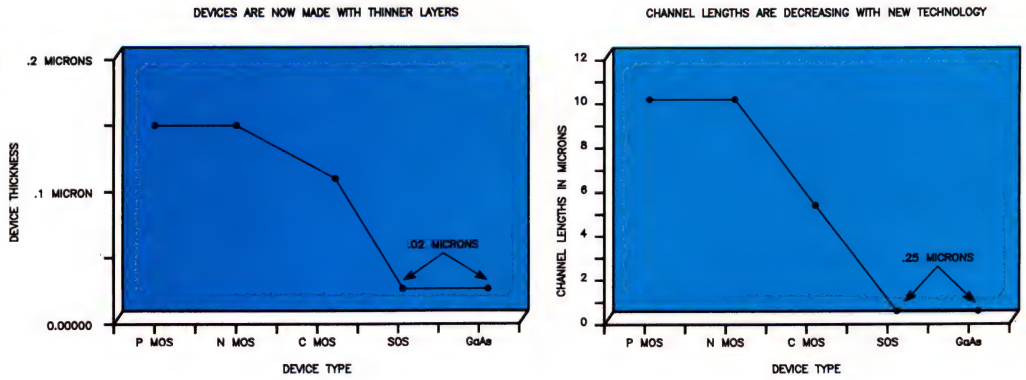
Many devices are rated according to the 'family' they belong to and component sensitivity varies according to complexity, geometry and the material from which it is constructed.

Device susceptibility rating is normally obtained from subjecting successive pins combinations to discharges and finding the lowest value that will destroy the device. This could mean that a device rated at 100 volts may only be that sensitive at two pin combinations and may be fairly insensitive at other combinations – try guessing which! General handling and pure luck may mean that a person charged with greater than 100 volts may never touch the sensitive combination or only touch them infrequently.

The damage level of a device is not the degradation level, research by McDonnell Douglas indicates that degradation can start to occur at only 25% of the destruct level.

The problem with most static damage is that, unless you have a big research budget and sophisticated facilities and can actually strip down components layer by layer, you can't see it. Fortunately, there is overwhelming evidence from ▷

As solid-state devices become thinner, are built with smaller channels and operate with less power, the need for static control will increase, rather than decrease.



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HANDLING RULES *for Static Sensitive Devices & PCB's using products shown below:*	OLYMPIC	SIMCO	T&B	3M	TRESTON		VOYAGER	OTHER
GROUND all workplace conductors, including people:								
★ Wrist, Heel, Sole Straps		•	•	•			•	•
★ Dissipative Clothing		•						•
★ Grounding Cords & Systems		•	•	•				•
★ Grounding Monitors		•					•	
★ Bench & Floor Mat/Runners	•	•	•	•				•
★ Hard Laminate Bench Tops		•	•	•	•			
★ Permanent Floor Covering			•					•
★ Floor Finish/Coatings		•		•				•
★ Carpet Treatment		•		•				
★ Field Service/Maintenance Kits		•	•	•				
★ Clean Ground Conditioners								•
IONIZE all workplace nonconductors:								
★ Benchtop Blowers								
<±30V Imbalance		•					•	
>±30V Imbalance			•					•
★ Blower, 10ft., <±30V Imbalance		•						
★ Airgun <±30V Imbalance		•						
★ Laminar Flow Bench Grid		•						
★ Cleanroom Filtered Airgun		•						
★ Cleanroom Area Grid		•					•	
SHIELD during transport and storage:								
★ Metallized Transparent Bags		•	•	•				
★ Conductive Foam — Urethane		•	•	•				
★ Conductive Foam — CL Polyethylene				•				•
★ Conductive Containers — Small Parts	•			•	•	•		•
★ Conductive Containers — Kitting Trays	•			•				
★ Conductive Containers — W.I.P. PCB's	•			•	•	•		
★ Conductive Containers — Tote Boxes	•			•	•	•		
★ Conductive Containers — Dip Tubes	•			•				
TEST & MEASURE								
★ Personnel Voltage Tester							•	
★ Static Fieldmeter		•		•				
★ Wrist Strap Tester		•		•			•	•
★ Resistance To Ground Meter							•	
★ Surface Resistivity Meter							•	
★ Shielding Bag Tester								•
★ Ion Current Meter		•						
★ Ionization/Decay Analyzer		•					•	
★ ESD Simulator								•

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Phone: (02) 750-4005. Fax: (02) 750-5224.

existing research that not only shows how the damage occurs – but how to avoid it.

Much static damage is often wrongly attributed to general failures whereas research indicates that up to 50% of high level IC failures are directly attributable to static damage.

There are some popular myths that have grown up around the industry and it is perhaps wise to correct them. The first is that *"If an assembly passes final test – it must be OK."* Truth is, you had better look at the history of the unit for up to two years to make sure degradation hasn't affected its performance.

"Components are safe on a pc board" – in fact, they can be more at risk since tracks can act as antenna and good paths for discharges and voltage fields.

"Components have input protection" – most components and boards with protection 'tend' to have less problems. However, they still have problems.

"Higher humidity will solve the problem" – the best humidity will do is minimise an existing problem. Increasing humidity will cause other problems with equipment corrosion, unhappy staff and soldering difficulties.

Controlling the problem

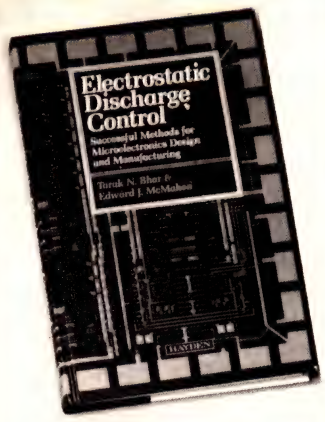
Static damage is caused by charged objects! Therefore, if objects were not charged the problem would be eliminated. An ideal situation would exist if triboelectric charging did not occur. At best, we can modify the behaviour of some materials and make them less prone to charge generation with the use of 'antistatic' products.

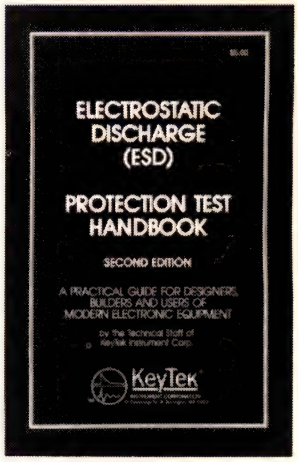
Minimising charges is difficult and very much a hit and miss exercise. The electronics industry accepts that charges will constantly be generated and these charges should be controlled. Static sensitive items can be protected by removing charges from objects with which they come into contact or proximity to or, when this is not possible, by "shielding" them from the charges.

Charged objects fall into two categories, either they are conductors or non-conductors. Charge can be removed from conductors by grounding and from non-conductors with ionised air. When sensitive items are in transit or storage they should be shielded. This gives us three basic methods of control:

3M looms large in the ESD control field, manufacturing and distributing a huge range of products. This static-dissipative Portable Field Service Kit, Model 8501, is designed for servicing electronic equipment in the field. It provides a static-free surface upon which to lay parts and to work. Included are two 3M Charge-Guard 2200 Series wrist bands and a 3051 Ground Cord.

The kit drains away any existing charges on the user or conductive parts or tools laid on the mat and prevents the accumulation of any new charge.





LITERATURE

Two books on Electrostatic Discharge are available locally, from two separate firms, one in Melbourne, the other in Adelaide.

Electrostatic Discharge (ESD) Protection Test Handbook, produced by the technical staff of the US Keytek Instrument Corp., was written specifically for people involved with testing equipment and circuits for ESD susceptibility. In 65 pages, the book covers basic ESD phenomena, various test specifications, design alternatives and test methods. This is the second edition and new sections describe recently acknowledged effects such as hand capacitance for fast-rising currents and the importance of approach speed in accurately simulating human ESD. The book is available on request from **The Dindima Group P/L, PO Box 106, Vermont 3133 Vic. (03)873 4455.**

Described as "the definitive text on ESD control", the 194-page hard cover tome, *Electrostatic Discharge Control,* by Tarak N. Bhar and Edward J. McMahon, reviews ESD theory and failure modes of electronic devices and discusses various protective equipment and test methods. To round out the narrative, the authors provide a description of how to establish an effective ESD control program in your business or workplace. Published by Hayden, it is available through **Componentronics P/L, 64 Sturt St, Adelaide 5000 S.A. (08)212 5999.**

GROUNDING,

IONISING, and

SHIELDING.

Over the years, two basic handling rules have evolved. The first is:

HANDLE STATIC SENSITIVE ITEMS IN A STATIC SAFE WORK AREA,

and the second is:

TRANSPORT ALL STATIC SENSITIVE ITEMS IN SHIELDING CONTAINERS OR MATERIALS.

A static safe handling area controls charges on all objects including people that are in, or enter the work area, by reducing static charges to levels that are harmless to exposed components. Shielding acts to provide a Faraday cage to components in transit and storage by reducing to harmless levels the electrostatic fields to which devices are subjected. There are literally hundreds of products available that can ground, ionise and shield – welcome to the minefield of electrostatic product supply! And a minefield it is, with conflicting vendor claims, often misleading specifications and buyers who often do not have the ability to test the products supplied.

The work area is the critical part of any operation and there are certain basic rules that apply here – ground conductors and ionise non-conductors. Simple rules, maybe, but with a multitude of different products available.

Grounding

The single most lethal conductor in the workplace is people! about 70% of damage is caused by incorrectly or ungrounded ▷

STATIC GENERATED BY:	POTENTIAL MAXIMUMS GENERATED IN	
	Low Humidity (10-20% R.H.)	High Humidity (65-90% R.H.)
Walking across carpet	35 000 V	1500 V
Walking on vinyl floor	12 000 V	250 V
Working at bench	6000 V	100 V
Handling vinyl job packet	7000 V	600 V
Picking up poly bag	20 000 V	1200 V
Moving padded chair	18 000 V	1500 V

personnel. People are great static generators. We all have to move as we work, which means that triboelectric charge generation is occurring constantly – our feet are contacting floor materials, our clothes are in contact with other clothing materials, our skin and our hands are constantly in contact with other objects. Any movement means separation of materials in contact and this generates static charges.

When charged, we have an excellent set of probes in the shape of fingers! When we are not discharging to components we are subjecting them to voltage fields from our hands or body. People are the greatest hazard – they are also the easiest to control!

Your body is, in effect, a variable capacitor that constantly changes its size according to its shape and proximity to other objects and we are constantly feeding charge into that capacitor. Since we can't stop the charges being fed to the capacitor and since we can't eliminate the capacitor, we can do the next best thing electrically – ground the capacitor. If we ground it properly we can virtually dissipate charges to ground at the same speed they are being generated, the key word is do it properly!

Research has confirmed theory. Namely, that the maximum charge that can be retained on the human body is a function of the total resistance path that exists to ground. At one megohm our maximum retained voltage is less than two volts, at 10 megohms the figure is 11 volts and at 100 megohms it is 80 volts.

If we are handling components that could be degraded at 15 volts then obviously we need to keep the maximum resistance level to 10 megohms. The easiest and time proven method of operator grounding is through a wrist strap assembly (see illustration), since the wrist band can remain in good electrical contact with the skin and the assembly can be checked easily.

BASIC RULES FOR STATIC PROTECTION

Handle all static sensitive items in a static safe work area

A static safe work area controls charges on people and objects in the work area

When working in an unprotected environment, ground yourself to the equipment before commencing work and at all times while working

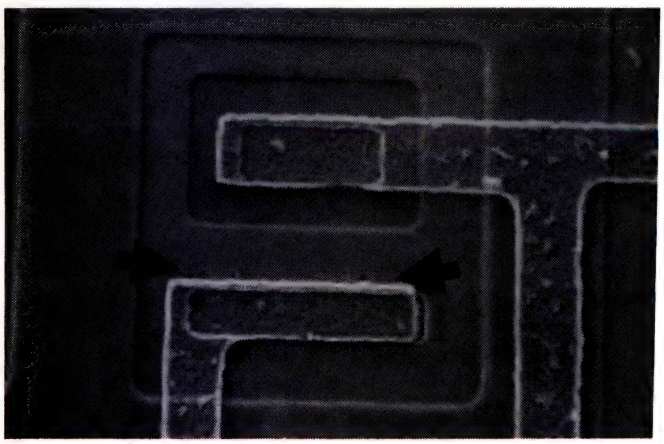
Transport and store all static sensitive items in static shielding materials or containers

This picture shows the degraded base-emitter junction of the input transistor in an LM101AH (mil-spec. LM301!) which failed due to ESD. (JPL).

There are many 'wrist strap checkers' on the market these day's, they are also misnamed items as they check more than the wrist strap – they also check the electrical connection with the operator. They act as low voltage meggers, usually operating between 10 and 20 volts, and test the product and operator as a circuit and give 'go', 'no go' indications within an operational "window" of resistance.

Other methods of grounding personnel are through contact with conductive or dissipative flooring. This works, providing that contact is permanently maintained through a similar resistance level as that of the wrist strap – not so easy with certain footwear and the high resistance levels of some flooring. In fact, the primary object of most flooring is to offer a safety net by lowering overall charge levels present in the environment, and to let the wrist strap assembly take the operator down to a predetermined voltage level – and hold them there.

The most critical surface in any safe handling area is the actual workbench surface and there are dozens of different types of material available ranging from soft cushioned materials to hard laminates. The work surface material has one basic function – it MUST control static charges. The material should not only be able to remove charge from conductive objects on its surface it must also not retain any charges. ▷



Even voltage regulator ICs can suffer electrostatic damage! This picture (900x mag.) shows degradation due to static incurred inside a common LM723. Cracks are visible in the oxide layer atop the 'inverted-L' track, which is the base of a transistor. (JPL).

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Conductive linoleum floorings

linodur LG	R_A	$<$	$1 \cdot 10^7\ \Omega$
	R_{ST}	$\geqq$	$5 \cdot 10^4\ \Omega$
marmorette LCH	R_A	$<$	$1 \cdot 10^8\ \Omega$
	R_{ST}	$\geqq$	$5 \cdot 10^4\ \Omega$
uni walton LCH	R_A	$<$	$1 \cdot 10^8\ \Omega$
	R_{ST}	$<$	$5 \cdot 10^6\ \Omega$

Conductive PVC floorings

deliplan LG	R_A	$=$	$1 \cdot 10^4 - 3 \cdot 10^5\ \Omega$
royal 40 LG – 2	R_A	$=$	$1 \cdot 10^5 - 1 \cdot 10^6\ \Omega$
royal 40 LG – 1	R_A	$\leqq$	$1 \cdot 10^7\ \Omega$
	R_{ST}	$\geqq$	$5 \cdot 10^4\ \Omega$
deliplast LG	R_A	$\leqq$	$5 \cdot 10^7\ \Omega$
	R_{ST}	$\geqq$	$5 \cdot 10^4\ \Omega$
deliplast LCH	R_A	$\leqq$	$5 \cdot 10^7\ \Omega$
	R_{ST}	$\geqq$	$5 \cdot 10^4\ \Omega$
PVC-table covering	R_A	$<$	$5 \cdot 10^6\ \Omega$

Conductive rubber flooring

profil L	R_A	$=$	$4 \cdot 10^3 - 3 \cdot 10^4\ \Omega$

Definition of the various leakage resistances	
$R_A \ldots$	*leakage resistance of the uninstalled floorcovering acc. to DIN 51953, measuring electrode by 20 sq.cm (value indicated by manufactures)*
$R_E \ldots$	*earth leakage resistance of the installed floorcovering measured via the earthing system acc. to DIN 51953, measuring electrode 20 sq.cm (value specified by the user)*
$R_{ST} \ldots$	*stand-point insulation resistance – resistance of the installed floorcovering to earth, definition and measurement acc. to VDE 0100, Sect. 24; measuring electrode 625 sq.cm*

DLW Flooring Systems Pty. Ltd.

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CROWS NEST N.S.W. 2065

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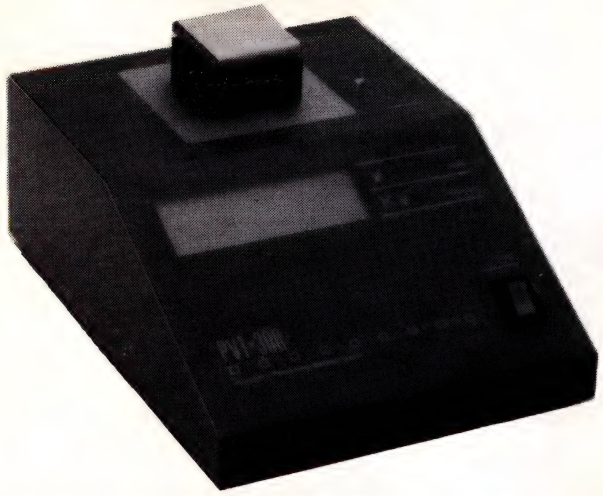


In any situation where you need to know the effectiveness of static control measures, or where static generation on personnel needs to be checked, there's only one sure way to get your answers – and that's to measure the charge any person may accumulate.

The Voyager PVT-300 Personal Voltage Tester is just built for this job. Walk up, touch your finger to the terminal on the top and it gives an instant voltage reading on the 3[1/2] digit display. The twin-range display shows up to 1800 volts (1 V resolution), and up to 9.99 kV (10 V resolution). With it, you can test the "before" and "after" effectiveness of conductive wrist and ankle straps, etc, as well as other ESD control measures. It is available from CLC Agencies, 51 Armitree St, Kingsgrove 2208 NSW. (02)750 4005.

Quite simply, we could make a work surface from a grounded steel plate and many years ago most surface coverings actually had similar electrical properties to steel. However, times have changed and conductive bench coverings are now a definite no-no (except in special circumstances). Power-up testing is both difficult and dangerous, high impedance and other circuitry can be affected by the large groundplane beneath it, and conductive materials 'encourage' discharges from charged objects in proximity, thereby creating troublesome localised RF signals.

Since most people do not expect to find this type of material in the workshop, there is the possibility that anyone working in a new area and 'powering-up' equipment on the bench could cause damage not only to equipment but also to themselves.

Work surfaces need to be conductive enough to drain static charges quickly, yet insulative enough to allow power-up testing and a large measure of protection to personnel, hence the development of dissipative materials. These are materials that are electrically between conductors and insulators and in theory offer the benefits of both. The U.S. Milspec 263 defines dissipative materials as having resistive ranges of 10^5 to 10^9 whilst the EIA specifies materials up to 10^{12} Ohms as dissipative – that it is a very large electrical range! Interestingly, engineers who would normally be quite horrified if they received a resistor a few percent outside specification will blandly specify a 'dissipative' material that 'could' have a specification between 100 000 Ohms and 1000 gigOhms!

The speed at which a surface covering material will remove charge is determined by the total resistance path that exists to ground. Typically, it needs to be greater than 10 megohms (to allow protection for power-up test situations) and less than 1000 megohms (otherwise charge drainage takes too long). In fact, some material users specify top limits below 200 megohms – all these figures are a far cry from the 0.1 to 1 000 000 megohms that the dissipative range encompasses. The speed of discharge is determined by the formula:

$$\text{Time} = l_n \frac{\text{(Initial Voltage)}}{\text{(Target Voltage)}} \times \text{Capacitance of Charged Object (in Farads)} \times \text{Resistance to ground}$$

Most operations prefer that the target voltage is achieved in less than one second. Here are two equations one for a material with a resistance to ground of 200 megohms and the other for a material with 3000 megohms resistance. We will assume that the charged object is a conductive tote box with a capacitance of 300 picofarads and the start voltage is 5000, which we wish to reduce to our safe level of just 10 volts.

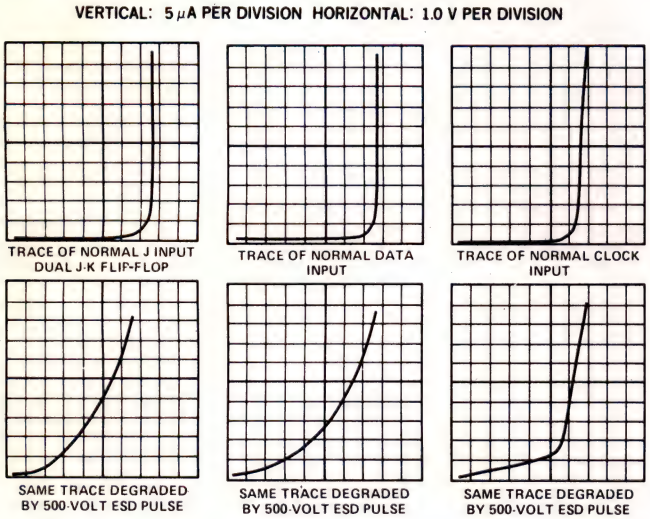
$$l_n (5000/10) \times 300 \text{ pF} \times 2 \times 10^7 \text{ Ohms} = 0.37 \text{ seconds}$$

$$l_n (5000/10) \times 300 \text{ pF} \times 3 \times 10^9 \text{ Ohms} = 5.59 \text{ seconds}$$

Quite plainly, the second material is providing unacceptable discharge times since a grounded technician will have to wait almost six seconds before reaching for the container. If the contents are touched before then, there is a very good chance of discharge occurring through the operator. In fact it may be even worse than the equation suggests, since high

ESD testing calls for some pretty strange and sophisticated equipment. This device, made in Switzerland by Schaffner, is an electrostatic discharge simulator (Model NSG 432). The device at the "business end" is a 'test finger', which may be charged anywhere in the range from 2 kV to 25 kV!

The device comprises a power supply, a pistol-shaped handheld unit (which you see here) with controls and display, a dc-dc converter and the 'test finger' which is exchangeable with other special test fittings. It is distributed by Westinghouse Systems P/L, PO Box 267, Williamstown 3016 Vic. (03)397 1033.



ESD effects are not always catastrophic, but can cause degradation in a device's performance, as these pictures of a dual J-K flip-flop performance show, following a non-destructive ESD event.

resistance materials tend to provoke voltage suppression (the old Q = CV formula) sometimes by a factor of eight!

Very few vendors will even mention voltage suppression or the other bug-bear of these materials – contact resistance. Dissipative material specifications are normally quoted as volume and surface resistivity with several manufacturers now quoting resistance to ground measurements.

Surface resistivity is a guide only to current flow resistance on the surface. Beware – the Ohms per square measurement,

Conductive flooring is widely used as a static control measure in many offices and workplaces where electronic and computer equipment is installed. The flooring in this Swiss Hewlett Packard office is PVC conductive flooring made by DLW in Germany. Local enquiries should be directed to DLW Flooring Systems P/L, 133 Alexander St, Crows Nest 2065 NSW. (02)439 5488.

which states that the resistivity should be the same regardless of the size of the square, does not hold good for some materials! Volume resistivity, again, is only a guide and some materials with complex multi-layer construction defy proper description in this category.

Resistance to ground is the only true performance indicator available and figures are normally obtained by 'megger- ▷

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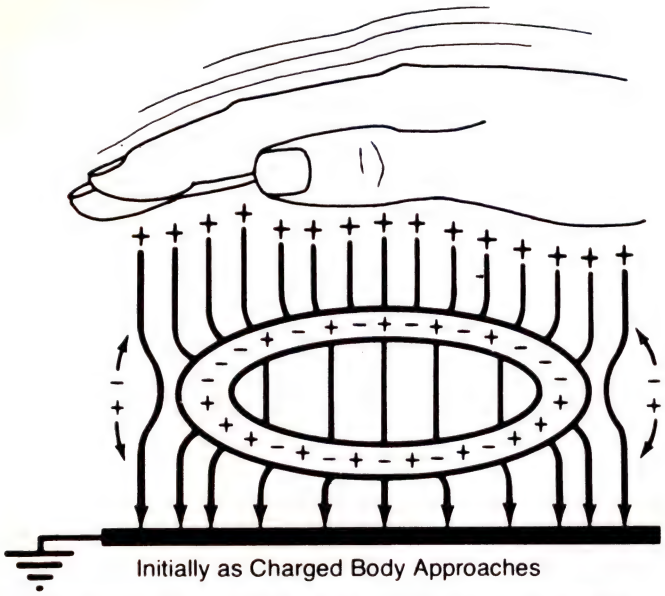
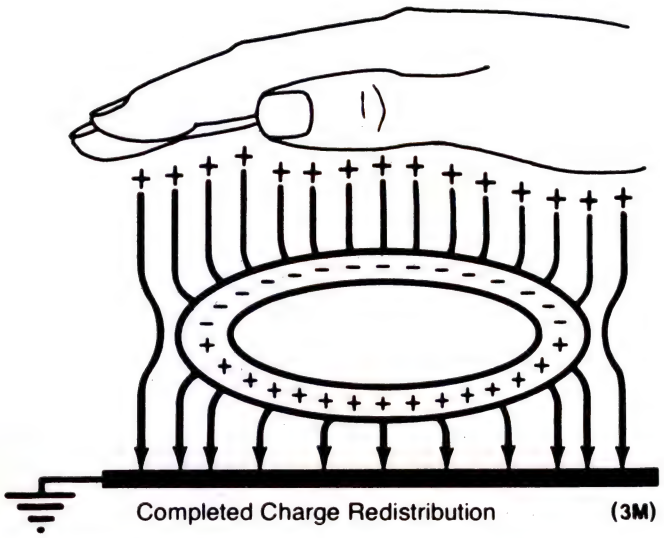


How charge is redistributed on a conductive container when a charged body (i.e: your hand!) approaches.



This principle is exploited with shield bags, pc board 'tote' boxes and conductive IC tubes.

ing' an industry acceptable electrode to the ground point of the material. Using two electrodes on the material surface will also indicate surface resistance. These tests simulate the real world environment of these materials – not their laboratory measurements. Determine the specification you need and test the material not only when new but during its working life to ensure its continued performance. Testing can be accomplished with low voltage meggers or with special test equipment available for the purpose.

Ionising

Non-conductors in the work area pose their own special threat. By nature, these materials do not allow free electron movement and cannot be grounded. Non-conductors exhibit voltage fields and can retain their charge for long periods. Where possible, they should not even be in the work-area. However, in the real world there will always be some of these materials in the workplace including tools, inspection equipment, etc. The only effective method of neutralising the charge on these materials is with ionised air comprised of positive and negative ions.

The American EOS/ESD Association recently produced a draft standard for evaluating and testing ionising devices. This draft has already achieved the status of de facto standard. Why? Because very few users actually understand how these products work and many vendors have for years been making unsubstantiated claims.

The two most important criteria for any ioniser is "does it produce balanced ionised air". If the ioniser is out of balance it may create more problems than it solves. The second is, "How effectively does it discharge a charged object." Note this is not how much ionised air is being generated, but how much is being delivered to a charged object, which is far more important.

Electrical generation of ionised air will always create some imbalance, which is commonly referred to as "offset voltage." Significantly, it should be less than plus or minus 30 volts. Performance is determined by measuring the charge decay of an object in the path of the air flow. Potential users of ionising devices should look for a specification that quotes the offset voltage and an isolated plate decay time, together

Shielding bags are widely used for the protection of pc boards during storage and transporting. They have three layers: an inner layer which is antistatic which allows objects to move inside without generating a charge, a middle layer which is dielectric (a plastic) that prevent current flow from outside to inside, and an outer layer which is conductive and forms a Faraday cage.

with ozone and EMI levels. Most other specifications are superfluous.

Shielding

Every time static sensitive items leave a static safe handling area they should be *shielded*. Shielding encompasses a variety of products from rigid containers to flexible materials.

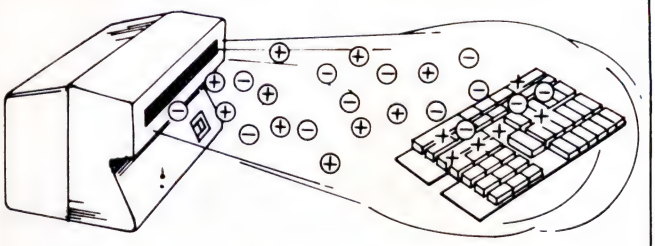
There are many different types of conductive plastics available – not all perform the same electrically. The EIA specification for shielding encompasses materials falling below 10^4 Ohms/square surface resistivity and 200 Ohms/cm volume resistivity.

Shielding is a complex function determined by both the conductivity of the material and its volume and many tests have been developed to actually determine the true performance of these materials. The most common shielding material is the static shielding bag. This product has three primary requisites – it should have an "antistatic" inner layer (this term is defined as being "antistatic" in accordance with the normal contents of the bag) which minimises charge generation as the contents move around inside. It should have a dielectric layer to prevent external current penetrating the material and also allow the transport of battery backed boards; it must have a conductive layer to provide shielding.

Shielding bag vendors make more promises than politicians at election time! Everybody's bag is "'better and cheaper" than someone else's, and some manufacturers are into gimmickery construction and fancy colours.

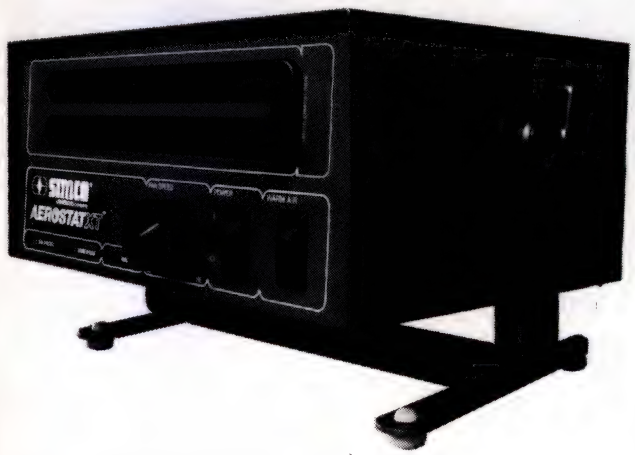
Shielding and bag performance are relative terms – you get what you pay for and that's a combination of performance and durability. If you want ultimate performance and are prepared to pay for it – buy the industry benchmark, the 3M 2100-series material. If you don't need super performance or durability, there are many other manufacturers to choose ▷

To quickly identify the source and level of electrostatic charge, Rheem Protective Packaging Products supply this US- made handheld "Autostat" Electrostatic Locator, Model 224CL. It provides indication up to ±25 kV in three scales of 5, 10 and 25 kV. Contact Rheem Protective Packaging Products, 3 Burrows Rd, Alexandria 2015 NSW. (02)519 4211.



It's relatively easy to get rid of static charge on a conductor, but what about non-conductors? The only effective method is to "neutralise" charged non-conductors using ionised air. This is done by employing an "ionised air blower" which supplies a constant stream of both positive and negative air ions. Any charged non-conductor then attracts the oppositely-charged ions to its surface, thus quickly neutralising the charge, as illustrated above.

Shown below is a commercial ionised air blower made by Simco, the Aerostat XT, a 'portable' unit which can be placed in any work area requiring ionised air charge neutralisation for ESD control. Further details from CLC Agencies, 51 Armitree St, Kingsgrove 2208 NSW. (02)750 4005.



from, including Simco, Richmond, Thomas & Betts and Static Inc.

When choosing a shielding bag, make sure it is labelled. If the manufacturer is not prepared to put his name on it, ask why? For performance, look for 'testing' in accordance with EIA IS 5A standards as this organisation has developed tests that simulate a 'real world' environment.

This article, by nature, has had to be compressed and many of the subjects by themselves could fill this magazine. However, readers may be aware that static control has changed over the past few years – and it is constantly changing as new technologies appear and research highlights new problem areas.

Awareness of the problem is the keynote as 'awareness' provides much of the solution both to decision making management and staff actually handling sensitive items. Overseas

◀ **Electrostatic discharge simulators are widely used to check the effectiveness of ESD control measures. The Keytek Instrument Corp. specialises in making calibrated ESD simulators which are claimed to duplicate "real world" ESDs.**

Keytek's MiniZap range of simulators provide accurate selection of voltage levels up to 15 kV and duplicate the rise time, intensity and stress levels of real ESD, the makers claim. They are distributed by The Dindima Group, PO Box 106, Vermont 3133 Vic. (02)873 4455.

computer manufacturers and Australian corporations such as STC, Telecom and Defence, and many companies, already incorporate programmes, but there are still areas where companies believe the problem either does not, or will not, affect them. If you work in electronics and believe the problem is going to pass you by then you had better go back to valves! To those that know and recognise the problem most controversy now revolves around true material performance and handling procedures.

Australia now has its own trade Association, the Australian Electrostatic-Discharge-Overstress Association. This Association is attempting to accomplish what the American EOS/ESD has done – namely, educate the market and set material performance and handling guidelines that are relative to Australia to enable our electronics industry to 'compete' static-wise with the rest of the world.

Win this Static-Dissipative Portable Field Service Kit from 3M and save those sensitive semis!

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Prize kindly donated by 3M Australia.

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1) What does triboelectric mean?

2) 3M are famous for their 'Post-it Notes' how did this marvellous invention eventuate?

3) '3M' is a strange name for a company. What does it actually stand for?

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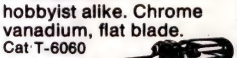

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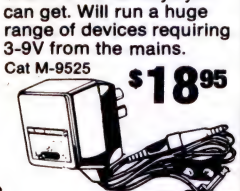

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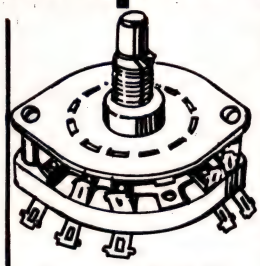

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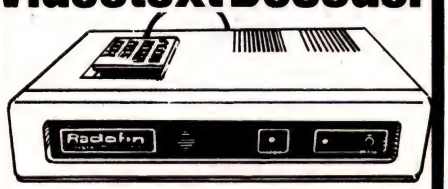

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The Versatile Power Supply

– a fresh approach to the variable power supply

"Not another power supply circuit" we hear you say – but fret not! We have tackled the perennial problem of combining features and performance with simplicity and economy in this novel and unique power supply circuit. And just to make sure that it suits your needs, we are presenting it in two basic models, with optional modules you can fit at your leisure. Your power supply problems are about to be turned off!

Jonathon Scott

IN THIS ISSUE we present the first of two power supply projects based upon a remarkable circuit which offers a number of highly desirable features. We have dubbed it "The Versatile Power Supply". The full range of benefits could not be incorporated into a single project, since the intended applications for the two supplies differ. The basic regulator circuit, presented here, is identical in both cases, but the configuration is changed by the addition of optional modules.

Simple and efficient power supply circuits based on the LM317/350/723 or 78xx and similar families of positive voltage regulators have been presented in many forms in the past. These devices, in the configurations hitherto described, have offered simplicity, economy, low to reasonable current capabilities and average performance in other areas.

The Versatile Power Supply circuit offers all of the above and a great deal more. Let's first examine precisely what we want from a power supply (and maybe some things we didn't know we could have!).

Power supply requirements

A lot of power supply circuits have annoying shortcomings which make them unsuitable for a number of applications in one way or another, viz:

- Some won't let you adjust the output down to zero volts. Circuits based around the otherwise-brilliant LM317 IC often have this problem, since it regulates down only to about 1.2 volts (the "bandgap" level).

This may be fine in some special cases (such as the powerful "lead-acid battery replacement" power supply (AEM2515) currently under development for AEM) but it is a nuisance for making lab measurements of devices such as LEDs or Schottky diodes or for developing and testing equipment designed to run off one cell.

- Some supplies need "bias rails". Supplies using the 317 can get to zero volts output if they have a negative bias supply incorporated. The problem here is that they are tied to using some sort of source with a negative rail, such as a special power transformer. If the supplies are a tracking pair of positive and negative supplies, they can share each other's rails, which would be there anyway, but this is a nasty answer to the problem, because the pair of supplies are fixed in series, so you can't parallel them for more current, or operate them independently in any way.

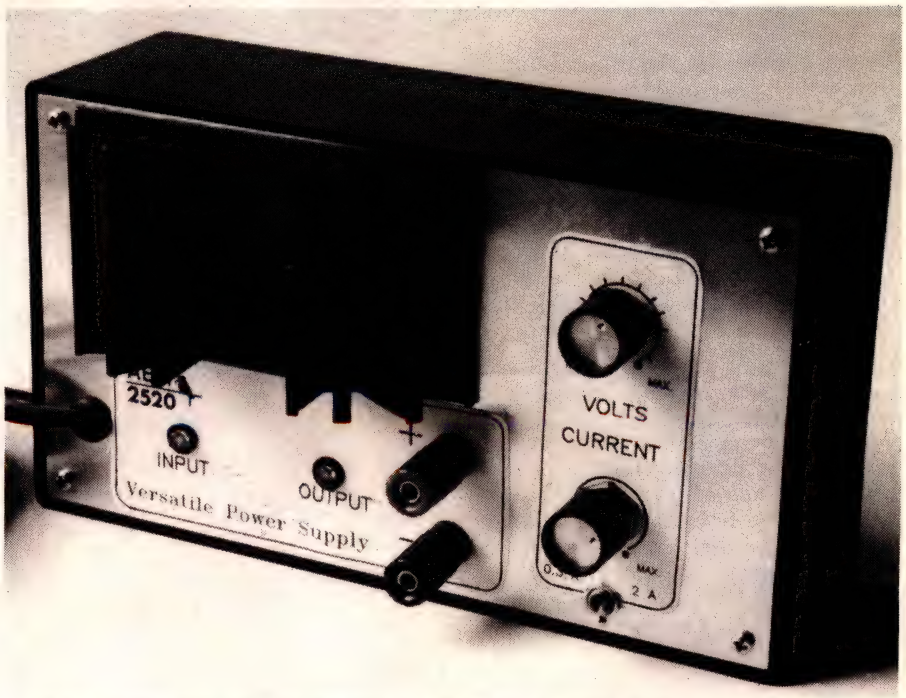
Hence the idea of special rails, while suitable for a commercial supply, is quite unacceptable for a general purpose constructor's supply, which needs to run off a single input voltage source.

- Next we come to the minimum current requirement. Many switching supplies, while very efficient, demand that you draw 20% of their full rated output all the time. Ugh! Even the LM317 has this problem, for it demands at least 10 mA load to function.

(This complaint actually goes hand in hand with the zero output and bias supply problems, because you cannot get a load current with no output volts and no bias supply, of course.)

- Related to the above problem is that many power supplies have a high quiescent current. Not so much of a problem if you have a hefty mains transformer, but if you are working from rechargeable batteries or a very small transformer, it's not on. A battery powered unit, a supply suitable for youngsters to tinker with, or one using a small transformer for size or weight reasons, cannot throw 20-50 mA away.

- Being able to operate with a low overhead voltage is another economy which is missing from a lot of supplies. If your unregulated supply is 12 volts, and the supply needs 5 – 6 volts over and above ▷



We will present two projects employing the Versatile Power Supply circuit. The first, AEM2520, is ideal for beginners. It commences on page 60.

the output to regulate successfully to 2 amps, you don't really have much output capability.

The same argument holds, though it is less pronounced, when the rail is, say, 28 volts. In that case it would be nice to be able to get to 25 volts on the output.

• The actual *quality* of the output power supplied can be important. Low output ripple and noise are very important if you are designing a piece of audio equipment. Many commercial supplies have specifications for their ripple, but what sort of rubbish can be evident at frequencies that are not mains related?

The output noise situation could be held in control by putting a *dirty big capacitor* right on the supply terminal connections, as is done in some commercial units that we have from time to time worked with, but this is not a good idea, as it ruins the short circuit response of the supply (as noted next).

• A supply should respond "gracefully" to the application *and* release of a short on the output. If there is a large capacitor connected to the output terminals,just inside the box, it will discharge the energy it contains into an apparent overload no matter what current limiting is acting in the electronics.

Suppose you set the supply to limit current at a level that is safe for a certain diode. Now, put that diode across the terminals of the supply, with the aim of making some measurement on it. The capacitor can deliver a surge quite large enough to kill the diode. Believe us, we've done it! Thus a capacitor across the output terminals is a bad move. The supply should go into current limiting *quickly.*

In the reverse case, what does your lab supply do when a short is released? Does it come carefully up to rated output, without overshooting, or is there a short peak? Most supplies have a small amount of overshoot – a consequence of other tradeoffs in the control loop doing the regulation. This peak, however, should be small enough not to harm whatever is connected to the output terminals.

• A power supply is much more useful if it has a continuously adjustable current limit. Some have a switchable pair of limits, such as 200 mA and 2 A, and this is often enough. Again, however, there are situations where you want to control the limit accurately. If the supply is being used as a current source, it should have a continuously variable adjustment to the current. Do you ever charge batteries using a lab supply? This needs current control.

Do you ever want to set the supply so that a small transistor (100 mA max.) or LED (30 mA) cannot be harmed? You'd be surprised how useful such a facility is.

Our second project employing the VPS is a fully-fledged "lab." supply, the AEM2521, coming next month. The front panel Scotchcal had not been applied when this was taken.

• A basic requirement of a lab supply is that of low output impedance. This is the same thing as "load regulation" for dc, but in the specification of output impedance, there is some connotation of frequency dependence. It is no good if your supply has a regulation of 1 mV from zero to 1 A measured on a dc voltmeter (implying an output resistance of 0.001 Ohms), but an output impedance of an ohm or two at a couple of kilohertz. Testing an audio circuit on a supply such as this is going to severely compromise the circuit's performance!

A common method of dealing with this is, yes again, a big capacitor on the output. This is a problem in some of the early op-amp-based supply designs.

• A rarely demanded, but occasionally useful property, is the ability to run on a wide range of input voltages. For home constructors, it's handy if the project can accommodate any sort of transformer you can dig up from the odd-parts box or scrounge from somewhere.

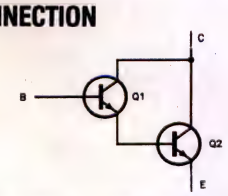
• A decent output current capability is nice, too. Often you want a lot of current, but not for long. The ubiquitous "30 volt 1 amp" or "30/1" supply is good enough for most things, but we often find we need an amp and a half for some audio amplifier or radio transmitter, and it is easy to draw 2 A in a logic circuit.

• Naturally, a supply should be "bullet-proof", which means that you can't blow it up by applying external power of either polarity (as in mistakenly trying to charge a battery in reverse!).

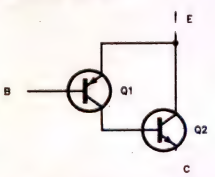
• Finally, there is another property which mathematics shows is near impossible to achieve unconditionally, but which ought to be closely approached. That is, the supply should be stable with any inductive or capacitive load.

As we said this is tricky to guarantee, especially if you have a lot of gain in the feedback loop to achieve some of the other goals. In practice, this is only a

THE SZIKLAI CONNECTION



The Darlington pair, here configured as a single high-gain npn transistor.



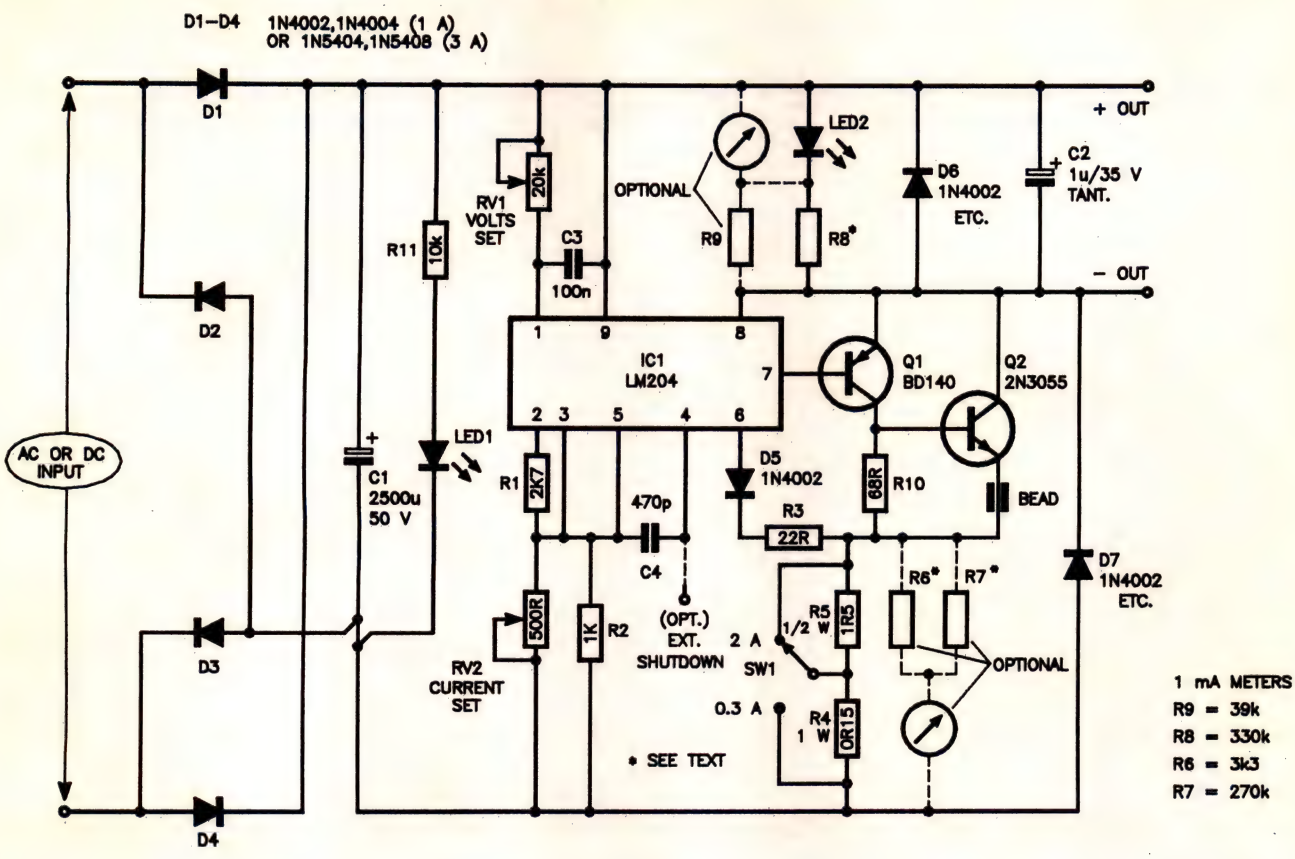
The Sziklai connection, configured as a high-gain pnp transistor

There are two basic arrangements in which two transistors can be connected to obtain "beta multiplication", providing a high degree of amplification. Both of these methods tie two transistors together in such a way as to form what is effectively a single, high gain transistor.

The most common of these is the *Darlington pair,* in which two transistors of like polarity have their collectors tied together, and the emitter of the first is connected to the base of the second.

This combination has only a single base-emitter drop, but it also cannot saturate to less than a single diode drop. This connection is common in push-pull power output stages where the designer wishes to use one polarity of output transistor only.

A less common configuration is the *Sziklai connection, sometimes referred to as the "complementary Darlington."*



problem with circuits that have been made *too* simple.

To be specific, simple two-transistor supplies suffer stability problems because of the parasitic elements inherent in semiconductors. In supplies which are inclined to instability (and this can easily be at 100 MHz where simple CROs can't "see" too well) a high performance bypass capacitor connected with the load can actually aggravate the problem.

This discussion should convince you that supply design is not as simple as you probably thought.

The VPS circuit

The circuit upon which we are basing this power supply banquet is based around the under-appreciated LM204/304 IC series from National. This is actually a *negative* regulator IC, and its introductory blurb says that it is intended as a negative version of a standard positive regulator part. This statement is false modesty, and has probably resulted in the failure of the electronic community to see what was offered. A data sheet is reproduced elsewhere in this issue.

In fact, the 204 can pretty well provide all the nice properties we muttered about at length above, with only a little cunning and the addition of a carefully stabilised Sziklai pair (see box) of common bipolar transistors.

At this point, we refer you to the discussion of the operation of the circuit in detail, if you want to know how the thing works exactly. This will be found, as usual, in a boxed panel accompanying the construction details for the project.

Our first project based on this circuit is the AEM2520 Versatile Power Supply. This version makes best use of the fact that the circuit has extraordinarily low quiescent current, and can operate on any single supply source from about 10 volts to 40 or 50 volts dc, or about 8 Vac to 35 Vac.

It is intended as a low cost lab quality supply for beginners, as a cheap and safe supply for youngsters, or as a supply for servicemen and people who want a small unit that can be carried in the tool kit or car.

It is suitable as a beginners' supply because it is simple and cheap, yet is capable of delivering a hefty 2 A, a useful 35 V or more, and with very good electronic performance.

It is suitable as a supply for youngsters, as it can be run off a couple of 6 V batteries (thus being totally safe) – 'dry' lantern batteries or a 12 V rechargeable type – and because it will not flatten these rapidly by itself.

It is suitable for servicing and mobile applications because it is compact, will run from (almost) any supply, ac or dc, batteries or transformer, without being too choosy about the voltage. You can even run it off an audio signal if you prefer, though we can't imagine who is likely to get caught with no other source of energy than that...!

The next version will be a fully metered 35 V/2 A mains- powered lab supply, at a surprisingly low cost (AEM2521). This will offer the considerable flexibility with respect to the mains transformer that you use, and the usual full range output, given the input voltage.

It will be teamed with two small projects designed as "retrofittable" modules for almost any power supply. These will add crowbar load protection and thermal monitoring facilities of the mains transformer and electronics, so that a simple low cost 1A transformer can be safely used with the regulator, yet still offering 2 A output capability. This last trick is a major assistance in achieving the cost/performance, and while it suits the Versatile Power Supply circuit, it can be used with virtually any supply you already have!

The Versatile Power Supply can be built in the basic version shown in this issue, and can be easily modified for mains operation at a later date, if desired. Either of the two protection modules can be added to this (or *any other* power supply), likewise whenever your needs warrant it. See what we mean by *"Versatile"*?

Now, having whetted your interest, it's time to get on with the project!

An Australian Electronics Milestone . . .

ONE MILLIONTH FUN WAY KIT!

Sometime between the time you read this and the end of the year, the one millionth Fun Way Into Electronics kit from Dick Smith Electronics will be sold.

It's a picture of concentration but, by golly, he's gonna get it right! And best of all, when it's finished he'll be proud to say, "I built it myself!" If you join him and build a Fun Way kit over the next few months, you could be $1000 richer!

The one millionth kit came out of the production line at Dick Smith Electronics' North Ryde (Sydney) headquarters only a matter of a few weeks ago. At the moment it's believed to be sitting in the bulk store, ready for despatch to one of the Dick Smith Electronics stores or dealers.

It's a secret!

Exactly which kit is a closely guarded secret, known only to one person at Dick Smith Electronics. He'd been watching the stock figures for several days as the millionth kit neared completion – and when it did, he quietly slipped in and added a little "bonus", unbeknown to anyone else.

That bonus is a special gold star, which can be redeemed at any Dick Smith Electronics store for, wait for it, $1000 worth of goodies.

Whatever you want – more Fun Way kits, larger kits, test equipment, components (think of all the resistors you could buy for $1000!), even a computer, if you wish (the ACER 500+ computer from Dick Smith Electronics sells for $995 – so you'd even have $5.00 left over!)

There's only one kit containing the $1000 Gold Star, but with the special offer on Fun Way kits this month, everyone gets a present. But more on that shortly.

When and where will it be sold?

Exactly when it goes out, and into which particular store, is anyone's guess, because stores order goods from the warehouse as they need them. But one thing's for certain – the production plan requires that all the kits will be out of the warehouse and into the stores before the end of October.

And because of the huge demand for kits before Christmas, it is 100% certain that the particular kit will be sold well before then. It might be that the kit is sold next week . . . or it might be that some lucky person will open up their Christmas presents to find they've more than they bargained for!

The Fun Way Story

One million kits is a pretty big number in anyone's language – so let's have a look at how this remarkable feat came about.

Needless to say, one million Fun Way kits weren't sold overnight! It has been nine years since the first Fun Way Into Electronics book was written, and the first kit produced. And that is a story in itself.

Fun Way 1

Hobbyists in Australia have always been pretty lucky when it comes to building projects. Our electronics magazine projects have been the envy of the rest of the world – the variety and the number, especially considering the population, is staggering!

Equally, we've been pretty lucky that a number of electronics companies have been willing to "take a punt" and kit up for these projects – often with no guarantee of even breaking even, let alone making a profit!

Needless to say, the ubiquitous Dick Smith was at the forefront of such kit development, often spending a lot of time and money in sourcing hard-to-get parts for particular magazine projects.

But Dick was not satisfied with the level of kits for the absolute beginner. There had been a few attempts at projects for beginners, but there was nothing the beginner could really work through and turn into an electronics hobbyist. And Dick knew that electronics hobbyists bought bigger and better kits – and more components!

Dick recalled his boyhood days building kits literally strung together on 'breadboards'. Nothing fancy, nothing which cost too much: "That's how kits should be made!" And he recalled how much fun he'd had as a boy building the kits. "If kids have fun building the kits," he reasoned, "they'll be back for more."

So Dick Smith's Fun Way into Electronics concept was born. Dick got together with designer Sam Voron, writer & layout artist Ross Tester and illustrator Mike Middleton, and came up with 20 easy-to-build projects, using basically the same components, all built on his boyhood 'breadboard.'

The decision to provide cut-out circuit templates for the kits was a stroke of genius: instead of a beginner having to remember which component was which, and try to get it right on the breadboard, he or she literally followed the circuit – by screwing the components together on top of it!

That made one of the most difficult concepts of electronics – the circuit diagram – literally child's play. Instead of squiggles on paper, the beginner could immediately identify the component. Hey, this was FUN!

The only thing left was to explain to the beginner what the components actually looked like, what they did, and what all the 'technical' terms meant. Put it all together and "Fun Way Into Electronics" was ready.

Well, almost. The kits then had to be made to suit the projects.

As mentioned, most of the kits used similar components, so another marketing masterstroke was made. The first ten projects all used fairly basic components, so a kit was made (at a very low cost) to build any of these ten projects.

The remaining ten kits used the same components as the first ten, plus a slightly more specialised group of components. These more specialised components were put together in a 2nd kit which, when added

to the first, allowed any of the projects to be built! Again, the cost was kept very low to make it attractive.

An instant success

To say Fun Way into Electronics was a runaway success would not just be a cliche, it would be an understatement!

So much so that in the first year a second printing was required – and today, the 14th printing is about to come off the press. When you consider that each printing is at least 5000 copies (and often 10,000), it's not hard to see why Fun Way into Electronics, and the projects in it, have been so popular.

"We want more . . ."

It wasn't long before the letters started coming in. "I've built all the projects in Fun Way into Electronics. Some of them ten times. What's next?"

Never one to miss an opportunity, especially one handed to him on a plate, Dick recalled the old team.

1980 saw the genesis of Fun Way Into Electronics, Vol 2.

"This time," he said, "I want slightly more difficult projects, something they can really get their teeth into. But I want every project to do something, to actually be useful. Something the kids would be proud to show Mum and Dad, or their teacher at school, and say 'I built it myself!'"

The projects were designed, tested, redesigned, re-tested . . . and then came the big decision. "Let's introduce printed circuit boards – and if they don't know how to solder, we'll teach them that too!"

As Fun Way Into Electronics Volume 2 was written, it became obvious that building the projects was only the beginning. In keeping with Dick's philosophy of "fun way" the projects each had a "what to do next" section, describing further experiments, modifications, etc that could be done.

And just in case, all the projects were fitted with a polarity protection diode and a current limiting resistor – just in case!

To make Fun Way Volume 2 even more interesting, special features were added – such as understanding electronics, milestones in electronics, pioneers in electronics, and so on.

Fun Way goes to School

Fun Way into Electronics Volume 2 quickly echoed the success of the first. A reprint followed before the first year was out, with at least one reprint, and often two, every year since.

Again, as we go to press, the sixteenth printing of Fun Way Volume 2 is coming off the presses – and that doesn't count the editions printed overseas. It's available throughout most of the English speaking world – and it is being translated into other languages!

Fun Way Volume 2 has become a recognised text book for a large number of schools, technical colleges, trade courses, electronics & radio courses, etc etc.

Please, Sir, I want some more

It was almost inevitable that a Fun Way Volume 3 would come out. This time, the projects were made deliberately higher in level – though still not out of the "novice" stage. Each project features an integrated circuit (or two, or eight!).

In Fun Way Volume 3, there are ten different projects to build, ranging from a two-up game to a mini synthesiser – but the most expensive kit is priced way under $20, so they're not up in the super-kit class. And even more than Fun Way Volume 2, there is masses of information to try out, to extend or to experiment with the projects.

Need we say it: five printings since Fun Way Volume 3 was released, thousands upon thousands of kits sold . . . it has taken its place in the Fun Way Phenomenon.

Why build a Fun Way Kit in the first place?

If you're reading this magazine, it's a fair bet you're at least vaguely interested in electronics. It could be that you're a full-blown project builder, or even a professional in the game.

If so, you'll remember those first tentative steps. Like the day you built a kit which called for 'spaghetti insulation' and you used good ol' genuine Nanda pasta. Or like the day you built a kit and carefully Araldited every component to the copper side of the pcb – and then wondered why it wouldn't work.

Or perhaps you were the one who used the blowtorch to solder the IC's in place. Or even the one who wanted to find out how many Ohms there were between active and neutral of the power point with your father's multimeter.

Go on, admit it. It wasn't easy starting out in electronics. There wasn't much to help you, and there never seemed to be anyone to show you the way.

Fun Way will show you the way. Or your kids. Or the Scout Group or Radio Club. Or the pesky little brat next door who keeps wandering into your shack when the 99th station for your DXCC calls "CQ" at 30 over.

Fun Way Into Electronics is designed for beginners from about five to a hundred and five. And it's FUN!

A special FUN offer from Dick Smith Electronics

There's only one millionth Fun Way kit winner. But to celebrate the success of the Fun Way series, Dick Smith Electronics is making a special offer to Australian Electronics Monthly readers:

If you buy ANY Fun Way kit during July or August, Dick Smith Electronics will GIVE you the Fun Way book. Free, gratis and without charge!

That's right, you could buy even the cheapest Fun Way 1 kit (priced at just $3.85) and get Fun Way Volume 1, valued at $4.95 free!

Or, if you buy any of the Fun Way value packs which include a Fun Way book, they'll discount the cost of the pack by the amount of the book ($4.95 for Fun Way 1 packs, $6.95 for Fun Way 2 or 3 packs).

There's a coupon below if you want to use it, but if you don't want to cut your magazine, call into any Dick Smith Electronics store and tell them Roger sent you. (You might have to explain that you're after the AEM special Fun Way offer as well, but have a look at their faces first!).

Or, of course, you could ring Dick Smith Electronics direct toll free on (008 22 6610) or Sydney 888 2105. But then you won't be able to see their faces.

It's a great offer, and AEM thanks Dick Smith Electronics for making it through our magazine.

AEM/DICK SMITH ELECTRONICS FUN WAY OFFER

Choose the Fun Way book you want to get FREE!

It's simple: just take this coupon into any Dick Smith Electronics store, buy ANY Fun Way kit or pack, and the appropriate Fun Way book is yours — free of charge!

Name: .....

Address: .....

Electronics experience: .....

Fun Way Kit(s) ordered: .....

.....

FERRAM – promising new memory technology

Collyn Rivers

A totally new non-volatile memory technology, known generically as FERRAM, based on the integration of ferroelectrics and semiconductor products, has been developed by Ramtron Corporation, the Colorado Springs (California) based research and development subsidiary of local company, Ramtron Australia Limited. Apart from non-volatility, FERRAM is compatible with existing solid-state technologies, offers high speed operation and is suited to virtually all memory applications!

THE requirement for data storage in computers, collectively termed *memory*, is one of the fundamental cornerstones of computer technology. And the requirement for every more memory grows virtually daily. Solid-state memory is inherently faster, but is non- permanent. Magnetic media – in the guise of the floppy disk, magnetic tape or hard disk – are the major "permanent" data storage media. But getting data to and from magnetic media is slow, its major drawback. Solid-state programmable read- only memory offer another form of permanent data storage and has been around for some time. However, it has drawbacks in cost and size limitations.

Enter FERRAM. FERRAM essentially overcomes the fundamental limitation of existing solid-state computer memories – that they are 'volatile.' Electrical energy must be supplied continuously in order for data to be retained. If power is disrupted, even momentarily, all data held in memory is lost. Battery backup is widely employed but never fully trusted, particularly in critical applications.

Apart from the huge benefits of non-volatility, FERRAM appears to provide all the features that the computer and associated industries seek. Unlike existing memory technologies, in which specialised products are developed for specialised markets, FERRAM appears suited to almost all memory applications (as well as many others).

FERRAM is compatible with existing metal oxide silicon and gallium arsenide devices, has fast read/write capability, uses little power (it is both operated and switched by a five volt supply), can be built with high density. And it can retain data for up to ten years with no external power, and for several thousand years with power cycled once a day. In addition, FERRAM memory continues to operate in the presence of radiation – a fact of profound interest to the military mind – (assuming that is not an oxymoron).

The ferroelectric effect has intrigued investigators for the better part of this century – ever since J. Valasek discovered in 1921 that sodium potassium tartrate tetra-hydrate (better known as Rochelle salt!) could have the polarisation of its crystalline structure reversed by applying an electric field. Valasek apparently believed the material was unique (in this respect) but a series of other ferroelectric materials were discovered between 1935 and 1938. These included phosphates and arsenates.

Many further new ferroelectric materials were discovered in the 1940s – mainly as a result of a search for a replacement for mica.

Wul and Goldman discovered barium titanate during 1945/6. This material proved of great interest. Prior to its discovery, it was believed that hydrogen ion bonding was a pre-requisite for the ferroelectric state. Barium titanate proved that this was not so; further, it proved to be the first ferroelectric material to exhibit more than one thermodynamically stable ferroelectric phase.

Following these discoveries, hundreds of other materials with dielectric anomalies were discovered, and Ginzberg and Devonshire independently developed models for both polar and non-polar materials which described ferroelectric behaviour.

During the 1960s and early 70s, scientists began to seek a single unified theory for the ferroelectric effect (and larger scale phenomena!) instead of treating each material as a separate entity.

Working with a now reasonable theoretical framework (and rapidly developing thin-film processing capabilities) scientists Rohrer and McMillan devised and patented a method of integrating stable ferroelectric films with conventional semiconductor technology.

This new technology has been licensed to ITT Semiconductors in the USA. Ramtron and ITT will jointly own the

FERROELECTRIC?

Whilst the term 'ferroelectric' is commonly used by the associated industries, the term is inherently confusing. The prefix, 'ferro' originated with early attempts to explain phenomena related to (similar) properties of essentially iron-bearing compounds.

Magnetic disks and tapes today use a 'true' ferritic technology in which iron oxide particles are caused to be aligned in either of two directions.

The ferroelectric effect was considered as an alternative to the also non-volatile magnetic core technology (developed by Dr An Wang, founder of Wang Laboratories over thirty years ago) but ferroelectrical devices were not sufficiently advanced at the time.

As the demand for memory increased, magnetic core technology became increasingly displaced by current solid state memory: the latter's advantages of speed, size and low cost overriding the fundamental requirement for continuous electrical power.

mutually developed technology – with each company remaining free to design and market its own products.

The Krysalis Corporation (Albuquerque, New Mexico) is also actively pursuing FERRAM technology. A technology-exchange agreement has recently been signed by Krysalis and National Semiconductor whereby National provides Krysalis with product engineering, manufacturing and marketing support.

How FERRAM works

Certain dielectric materials are finitely and permanently polarised in the absence of an applied electrical field. This effect, known as 'spontaneous polarisation' is caused by an inherent asymmetry within the material's basic crystalline structure. This asymmetry causes ionic or electrical forces which in turn create elementary dipole moments which are additive – thus producing the aforesaid finite permanent polarisation.

In some such materials, the polarity of these dipoles can be be reversed by momentarily applying an external electric field (the polarity remains in the new state after the electric field is removed). Thus the '0' condition required for digital technology is one polarisation, the '1' condition is the other.

Since ferroelectrics are dielectric, it is readily possible to construct a ferroelectric capacitor which stores binary digital data (as described above) according to the manner of polarisation. What happens is something like this:

If a voltage is applied, thus charging the capacitor, the molecules (positive at one end and negative at the other) in the ferroelectric material align themselves with the electrical field. If the capacitor is *discharged*, the molecules remain aligned. If a further voltage is applied (of the same polarity) only a very small current will flow.

But, if subsequently, a voltage *of opposite polarity* is applied (but in the same direction as initially) a high current will flow and the molecules will realign themselves in the opposite direction. Data can be written to and read from such a device by applying an electric field greater than the threshold (coercive) level to the element and, in effect, seeing what happens! (Figure 1).

Ramtron Australia's US subsidiary, Ramtron Corporation, formed an R&D agreement with the University of Colorado to develop technology based on work began in the 1970's by the aformentioned Rohrer and McMillan – who had devised and patented a method for integrating stable ferroelectric materials with conventional semiconductor technology.

The goals were to develop a commercially viable non- volatile semiconductor technology that would meet the following goals:

- Retention of polarisation greater than 10 years,
- Endurance of greater than 10^{15} cycles,
- Breakdown greater than seven volts,
- Coercive voltage approx. 2.5 volts (and stable),

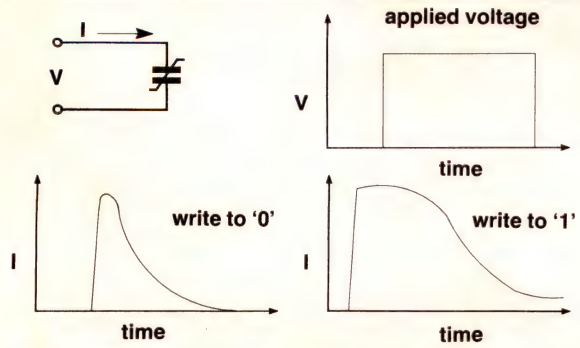


Figure 1. 'Writing' and 'rewriting' the charge in a ferroelectric capacitor. (Note the special symbol).

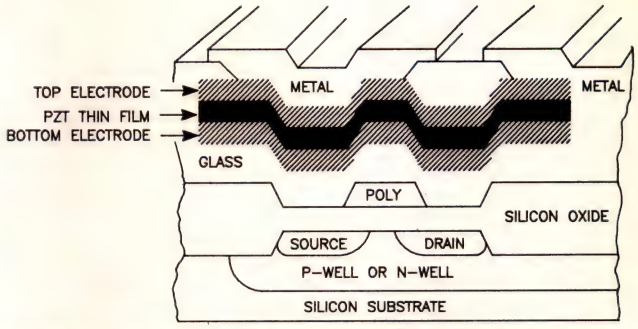


Figure 2. In this example, a lead zirconate titanate thin film and two electrodes form a 'digital capacitor' on top of a silicon-gate MOSFET.

- Full polarisation switch in less than 100 nanoseconds,
- Transition temperature greater than 200°C,
- Compatible with with existing semiconductor technology,
- "Radiation-hard" to strategic levels.

Following a study of over 700 apparently suitable materials, Ramtron selected four materials (or related compounds) for active evaluation. These were: potassium nitrate; bismuth nitrate; lead germinate; lead zirconate titanate compounds. Ramtron is continuing development on bismuth and lead germinate, but its major results have so far been achieved with the lead zirconate titanate compounds (PZT).

Ramtron's FERRAM technology uses a thin film of a ceramic lead-zirconate-titanate (PZT) compound sandwiched between two metal electrodes to form what in effect is a digital capacitor. Results so far have met or exceeded goals.

For normalised film thickness, threshold voltage is 2.5 V, 50% of a 5 V, supply with breakdown exceeding 40 volts.

The hysteris loop exhibits positive and negative slope differentials and usable signal amplitudes way in excess of that required for detection (with more than adequate noise immunity).

Switching time versus temperature (for 90% polarisation reversal) is nearly flat from (military temperature range) of – 55°C to 125°C with speed increasing as the material reaches its Curie temperature of about 380°C.

Retention of polarisation with respect to time has remained unchanged in experiments to data for 100,000 minutes. Currently, EPROM manufacturers use similar tests to 'prove' that their products have 100 years data retention. Ramtron agrees that whilst retention does not appear to a problem with their PZT based devices, more testing is required for this to be thoroughly established.

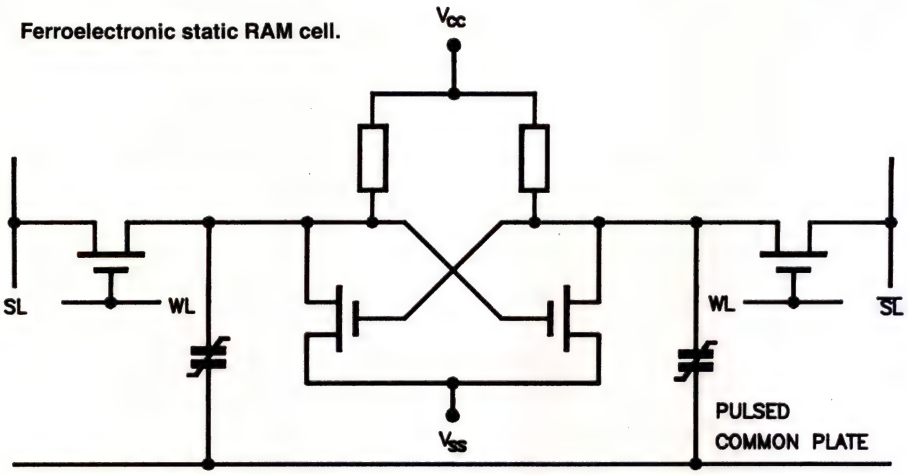
In the long term, molecules in ferroelectric materials cease to respond to reversed voltage applications. Currently results show a loss of charge value of 50% (of initial value) after 10^{10} cycles (which is a very large number, even in computer terms). Ramtron believes that endurance can be extended beyond this to enable even high speed switching at 10 MHz to be feasible – probably 10^{15} read/write cycles.

Figure 2 shows how a PZT thin film capacitor can be fabricated on top of a silicon gate MOSFET – taking up no extra board space. At present this requires three separate mask stages in addition to conventional semiconductor processing in which the metallurgy for the capacitor and the semiconductor remain separate – which is how the devices are made at present. Yes, they really do exist and 256 bit versions are available in the USA for serious customer evaluation.

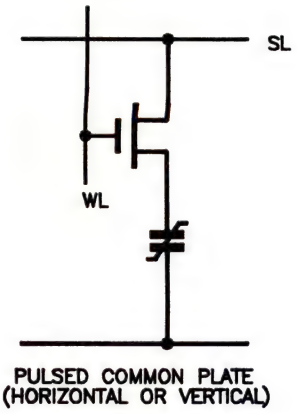
In the future it is expected that the devices will be manufactured using one technology. It's significant in this respect that Ramtron's devices are substrate independent: although all work so far has involved CMOS; GaAs, SOS etc can readily be used.

▷

Ferroelectronic static RAM cell.



Advanced 'FRAM' cell.



Where to now?

The most obvious initial application is to integrate the PZT chip into a practical read/write memory circuit. Figure 3 shows how this can be done – using a four-transistor static RAM cell interconnected by two PZT digital capacitors.

In this application the capacitors are only activated upon loss of power, then restore data upon regaining power. In this form, the PZT devices will theoretically store data *without power* for 10 years and last for >11,000 years at one power loss/hour.

Figure 4 shows a single transistor merged ferroelectric cell (which has an area equal to or less than a dynamic RAM cell) yet is static and non-volatile. This cell is currently being evaluated for potential use in a family of second generation devices.

Market projections

FERRAM technology is currently embryonic. Pre-production development examples exist but the manufacturers have to capture enough of some memory market to be able move further up the learning curve.

Given reasonable volume, production costs do not seem to be a problem. The US market research group Dataquest predict that the devices can be introduced at prices near those of EPROMS and that, by 1992, FERRAM prices will be significantly lower.

Essentially, FERRAM technology is shaping up to produce new classes of memory (and other) devices which have the ease of use and performance of static RAMS, the density and manufacturing costs of dynamic RAMS and the non-volatility of ROMS.

These devices are now far from experimental and unless unexpected production snags and costs arise they will probably change the very nature of computer memory technology and usage – including magnetic storage devices.

Ramtron's competitor, Krysalis has recently produced a 512-bit sample memory (called a UniRAM) and is working on 16 kilobit and 256 kilobit chips.

Dick Smith enters the video market

Video has been, up until now, one of the few areas of consumer electronics *not* covered by Dick Smith Electronics. But no more.

DSE has entered the home video market with the introduction to their stores of the Sanyo Vision 8 video system, consisting of a Video 8 camcorder, a VHS VCR and a "monitor-style" colour TV.

The Vision 8 Camcorder weighs in at just 1.27 kg, and boasts a 1/1500th second shutter speed plus the ability to operate in light levels as low as 9 lux. Additional features include auto focus, backlight compensation, auto white balance, 6x zoom, and a macro function that allows focusing as close as 5 mm.

The Sanyo Digital Picture VHS video cassette recorder is a remote control unit jam-packed with features. Up to nine individual frames may be viewed on the screen simultaneously, so that programmes may be viewed live in one corner of the screen while the VCR is playing a tape elsewhere on the screen.

To complete the system, DSE is also offering the Sanyo "Simple and Smart" monitor-look 34 cm colour TV.

The camcorder is retailing for $2499, the VCR for $1499 and the TV for $499. Just roll up at your nearest Dick Smith Electronics store (there's 59 of them) for a demonstration.

Philips' 4-Play

Philips have announced a new range of integrated audio systems dubbed the 4-Play, which stands for 3-in-one plus CD. (What else?)

The 4-Play systems feature vertical CD players, in which the compact disc is inserted in the same way as with a cassette deck. This method is claimed to be faster and easier than the horizontal CD tray system, and allows the CD to be viewed through the front panel.

Each system offers 60 watt peak audio power, dual cassettes, high speed dubbing, auto-reverse, AM/FM stereo tuner, turntable, and a five band graphic equaliser. The CD player has a 20 track memory, random access and digital display facilities.

The three models include a shelf unit at $959 (XC3006B), a floor standing unit at $1129 (SC3115B), and the deluxe model at a RRP of $1249 (SC3149). See your local Philips dealer for more details.

VHS-C tape path cleaner

Allsop, the US manufacturer of audio and video cleaning products, has added the VHS-C format to its line of video cassette tape path cleaners.

VHS-C is the compact version of the world's most popular compact camcorder format, according to reports.

The Allsop cleaner, which incorporates the company's patented wet cleaning system, is claimed to remove dirt and oxides from the entire tape path of a VHS-C camcorder. Individual pads also remove dirt and "ridge build-up" from the machine's capstan and pinch roller.

The environment in which camcorders are used is far more hostile than that endured by the home VCR. Using camcorders outdoors, at the beach or in the car is certainly not the ideal way to keep them clean.

The Allsop patented wet cleaning system is claimed to be the most effective and safe way to clean a camcorder, short of taking it to a technician to have it cleaned.

Allsop produce a full range of cleaners for VCRs, available at most consumer electronics, camera and record stores. More information is available from

Allsop Fidelity Accessories, PO Box 246, Double Bay 2028 NSW. (02)357 2022.

Convoy gets Harman Kardon

Convoy International P/L have announced their appointment as the Harman Kardon distributor for Australia, effective 1st March.

Convoy's existing range includes such quality audio products as B&W loudspeakers, Monster Cable, Adcom Electronics and Glanz cartridges.

Harman Kardon is an established name in hi-fi, having offered the first high fidelity receiver some thirty years ago, they claim. They will soon be releasing a new range of quality home and automotive audio components, which offer the promise of outstanding sound quality, superb construction with the goal of zero manufacturing defects.

Convoy can be contacted at **400 Botany Rd, Alexandria 2015 NSW. (02)698 7300.**

Introducing Prologue – a grand system

Pioneer Electronics has launched a new compact home hi-fi system, the Prologue, consisting of a turntable, double cassette deck, tuner and CD player.

This 22 watt per channel system drives a pair of two-way bookshelf speakers, and features a full three year warranty – including the CD player and its laser optics. Pioneer claim this to be the industry best.

The system's PD-Z71 CD player boasts twin D/A converters, digital filter, random play option, and twenty track programming. The double cassette deck offers a soft touch mechanism and high speed dubbing.

The Prologue system is available from your local Pioneer dealer for $999 – surely a grand system.

JVC introduces PAL Super VHS

Super VHS is now available on the European market for either PAL or SECAM systems. A year after first announcing the higher definition Super VHS format for NTSC systems, JVC specifications for the 625-line PAL version, and now the VCR has been unveiled.

The JVC HR-SR5000 Super VHS VCR should be available on the Australian market around September this year.

Conventional VHS VCRs are able to record about 250 lines of horizontal resolution, whereas a typical television broadcast delivers a picture with about 330 lines resolution. When used on a PAL system with its 625 scanning lines, Super VHS yields a horizontal resolution of more than 400 lines – exceeding broadcast quality.

Super VHS achieves its picture improvements by employing a larger bandwidth luminance signal (5.4 – 7.0 MHz for Super VHS vs 3.8 – 4.8 MHz for VHS), and by incorporating separate luminance (Y) and chrominance (C) signal processing.

The S-VHS Euro System is a unified standard, so tapes recorded in Super VHS in any PAL or SECAM area can be replayed on any other Super VHS Euro System VCR. In addition, and of more interest to Australian consumers, S-VHS VCRs can record and play back in conventional VHS mode, so protecting current investment in VHS systems.

Main features of the HR-S5000 VCR include resolution of more than 400 lines; HQ system circuits for VHS operation; "Super DA-4" Head System; flying erase head and insert editing circuit; noiseless field still, frame advance and slow motion at five different speeds; and variable speed search and playback (three speed options).

High quality sound reproduction is assured with hi-fi VHS stereo sound (dynamic range 90 dB), claim JVC. The HR-SR5000 also sports an advanced noise reduction system; audio dubbing; hi-fi recording level control with ALC switch; and peak-hold audio level indicators plus hi-fi tracking meter.

Ideal bass without a cabinet

Conventional loudspeaker design techniques have been swept aside by a process described in British patent application 2 191 065.

Graham Bank, of the Celestion company, has developed a process which is claimed to achieve improved reproduction of bass frequencies in a radical and unique manner.

According to conventional wisdom, a bass loudspeaker must be installed in a large, heavy cabinet if it is to efficiently reproduce low frequency signals. The purpose of the traditional cabinet, with its air-tight sealing, venting and sound-deadening wool, is to prevent sound waves from the back of the loudspeaker cone mixing with those from the front, cancelling each other out.

Bank's idea is to use two loudspeaker cones mounted on a simple frame facing each other, *without any surrounding cabinet*. The same electrical signal is fed to each speaker, but out of phase, so that the two cones move together to create a blended sound.

Performance, however, is dependent on the location and orientation of the speakers in the room. The result is poor if the two speakers are arranged either parallel or at right angles to a wall. If they are *angled* to the walls, it is possible to find a position by trial and error, at which the sound reflects constructively around the room and creates a theoretically ideal bass source, according to the report we saw. No mention was made of how you keep the family moggy from sharpening its claws on the speaker cones.

Drive your bass even harder

Mobile sound systems will never sound the same, since JBL announced their range of subwoofers designed specifically for automotive use.

Available in 30, 38 and 46 cm (12, 15 and 18 inch) models, the JBL subwoofers are capable of providing "thunderous amounts of low frequency response" from their 300-400 W rated drivers.

The speakers feature Symmetrical Field Geometry, 75 mm edge wound flat ribbon voice coil, specially treated cone materials and individually machined magnetic pole pieces and back plates. Frames are die cast aluminium with epoxy powder coatings.

Now you'll never be quite sure if that shaking in the car is a broken conrod or just a two bar riff from the rhythm section.

3RD BIRTHDAY CONTEST No.4.

Video fans – cast a Captain Cook at this!

Imagine winning this magnificent monitor-style 48 cm Sony Super Trinitron black screen TV, model KV-1982AS, worth $1149.

This stylish black-finish 48 cm TV receiver features Sony's Super Trinitron system, which uses an Aperture Grill screen in conjunction with a new computer-designed Panfocus Gun. Sony's one-gun three-beam technique is fundamentally different from the shadow-mask system used in most TVs, and is designed to produce sharper, brighter images with more precise colour, and freedom from the unpleasant "doming" effects which cause colour impurities.

The screen is flat and square-cornered, and includes an on-screen display to make the full-function infrared remote control even easier to use. Video (BNC) and audio (RCA) inputs are supplied for true monitor capabilities.

Prize kindly donated by Sony Australia.

1) Which came first, the Cathode Ray Oscilloscope or Electronic Television?

. . . . . .

2) In what year did Sony commence manufacturing televisions?

. . . . . .

3) Would you expect the aperture grille or conventional shadow mask television system to produce a clearer picture?

. . . . . .

Now, in 25 words or less, explain why you would like to win the Sony KV-1982AS Monitor Style Television.

I have read the rules of the contest and agree to abide by their conditions.

Signature: _____

Name: _____

Address: _____

_____ P/Code: _____

Phone: (___) _____

How to make successful home videos

Dave Jeanes

The modern video camera-recorder can provide a powerful means for self-expression. However, most of us fumble our attempts at movie making. The basic rules of this craft are before our eyes every time we watch TV, and here we will guide you on your way to achieving professional results.

THERE'S NO DOUBT that video camcorders will largely supplant the film cameras that currently hold the top rung of the ladder when it comes to everyone's requirement for "image recording" on a personal basis. The staggering variety, range of models, features and facilities, and the ease of use of modern film cameras would astonish the photographers of fifty years ago, when cameras and photography first began to reach out to the "mass market". That's virtually where camcorders are today – just beginning to reach out to everyone.

But video camcorders have an advantage that photographers didn't have fifty years ago – a well developed background in related techniques; a pre-evolution, if you like. Drawing on that, learning to exploit the benefits and facilities offered by today's video camcorders is a relatively simple task. You need to thoroughly learn about the "tools" – the camcorders – and take in the techniques, borrowing from the evolution of movie film and video photography.

No matter whether you're making a video movie for yourself, a club or organisation to which you belong, your school or work – the techniques are the same. Enough! Let's get under way.

The basics

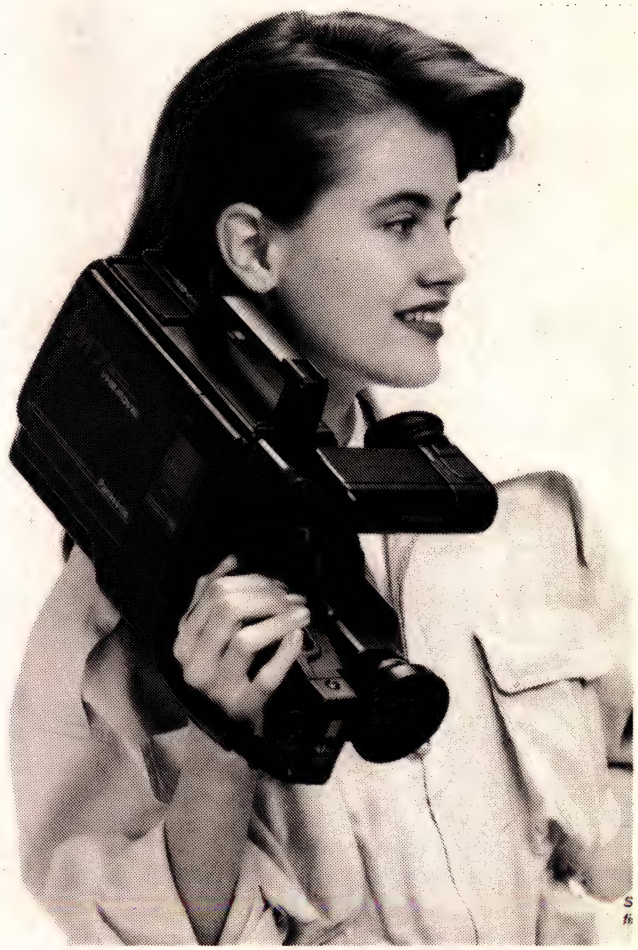
Although there are plenty of exceptions, the rules of movie making can only be broken successfully by the experts. In general terms the basic rules are:

1. Keep the camera still, or at least steady.
2. Make camera movement slow and smooth.
3. Keep the subject matter in focus.
4. When zooming the lens, make it slow and smooth.
5. Avoid bright lighting behind the subject.
6. Avoid any distracting background noise.

Each of these rules must be expanded upon to show how they can be used to advantage. Practically every one of them has been broken by the news cameraman, on occasions all of them together, in some vital footage. But we must stick to the rules to ensure our own footage is viewable.

Keep the camera still

Ideally, the camera should be mounted on a suitable tripod. In many home movie situations this is impractical. However, a tripod should be one of your first priority accessories. Nevertheless, hand holding the camera *can* be very effective in allowing a range of different camera angles to be obtained quickly whilst the action is taking place.



The larger camcorders incorporate a shoulder rest which is ideal for steadying the camera. The handgrip incorporates the major functional controls. (Pic courtesy Panasonic).

As cameraman, you are the eyes and ears of those viewing the playback. You should anticipate what they will want to see and hear. To be *effective* the subject matter, or at least the background when the subject is moving around, should remain steady on the screen.

The secret to obtaining a steady picture is to maintain the lens at a wide angle. As you change (zoom in) the lens angle towards telephoto, the image will become less steady, and at full telephoto it will probably wobble and jerk around sicken- ▷

"The best prices with unbeatable specs"

That's the GW Promise

20MHz

GOS-522

$790* INCL. PROBES

40MHz

GOS-543

$1,257* INCL. PROBES

Why buy just a basic 20MHz or 40MHz oscilloscope when you can treat yourself to a fully featured Vertical Mode Triggering oscilloscope with Auto Trigger Level Lock and Variable Hold-Off.

These extra features are normally not found on low cost oscilloscopes, but GW can offer them at a truly unbeatable price. How do they do it? Probably because GW are the leaders in cost effective CRO technology.

The GOS-522, for example, is a true 20MHz bandwidth CRO with a calibrated 20ns/DIV range (unlike CROs offering ranges calibrated to only 100ns/DIV where timing measurements become very difficult). Also, the Vertical Mode Triggering found on both the GOS-522 and the GOS-543 is especially designed for service applications. This allows you to simultaneously compare test points between good and bad boards.

Other features that make these CROs unique in their class include: Auto Trigger Level Lock ensuring perfect triggering without the need to readjust the trigger level when making measurements; Variable Hold-Off which is ideal for stable viewing of digital and video waveforms; fast 20ns/DIV sweep speed offering high precision; DC trigger coupling for low frequency signals and Auto, Normal and Single Shot sweep modes.

Features	GOS-522	GOS-543
Bandwidth	20MHz	40MHz
Channels	2	2
Vertical Sensitivity	1mV/DIV	1mV/DIV
Max Sweep Speed	20ns/DIV	20ns/DIV
Delayed Sweep	NO	YES
Trigger Modes	CH1, CH2, VERT MODE, LINE, EXTERNAL	
Variable Hold-Off	YES	YES
Delay Line	NO	YES
Accel. Voltage	2.2kV	12kV
Warranty	1 YEAR WARRANTY ON PARTS AND LABOUR	
Probes	2 QUALITY SWITCHABLE PROBES INCLUDED	
*PRICE INCL. TAX	$912	$1,465

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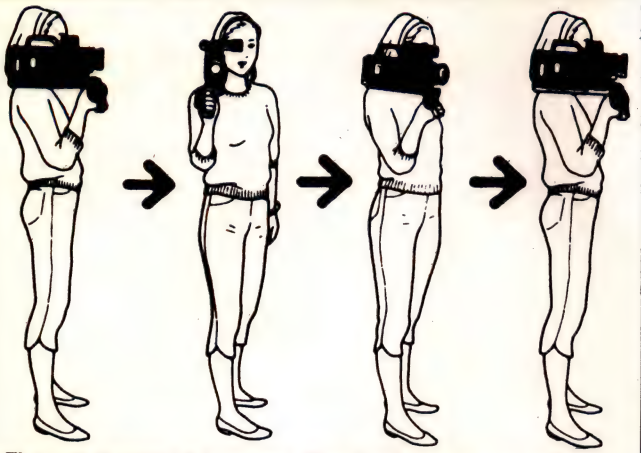


Figure 1. Panning the camera. Start by facing the direction (A) for the end of the pan, then swing your body around to start the pan (B), keeping your feet still. (Sony)

ingly for the viewer watching the playback.

Rather than zooming in and out, and panning (moving the camera horizontally), try to cover the subject by recording a few seconds of tape at a wide lens angle, then moving to a new position, closer in perhaps, and recording more tape. If your camera viewing angle is changed significantly for each "take" or "shot", the playback will be quite pleasing. You will be surprised how the sound track will also merge into a logical sequence.

Moving your position may require re-focusing for each shot. In bright light conditions the video picture will tend to remain in focus even if you forget to re-focus the lens. If you have an auto-focus camera, your shots should always be in focus. The secret is to keep the camera steady. Try some practice shots out in the garden, from various angles including close-ups, with a plant or flower, or even a person as your subject.

Slow, smooth camera movement

Slow and smooth camera movement will go unnoticed during playback. Rapid and wobbly camera movement will certainly be noticed and will spoil your movie.

Most amateur video camera work will be hand-held, so it is vital to practice keeping the camera steady, and to maintain a wide lens angle. If you must use telephoto for close-ups (zoomed right in) rest the camera on or against a support. Get your body and arms comfortable and the subject steadied before you press the record button.

Some camera-recorders have a feature called "back-track edit". When you stop recording, the tape winds back slightly. When you press the record button again, the tape advances, but a few seconds can elapse before the machine actually starts recording. If you hold the camera steady when you press the record button again, then start moving the camera before it starts recording, the playback will miss the pause and the shot will start on the move. This can irritate the viewer. This type of camera generally displays a "record" symbol in the viewfinder. When you press the record button, watch for this symbol to appear before you start panning the camera.

In many situations it will be necessary to move the camera horizontally (panning). The secret here is to keep the movement *slow*. Practise out in the garden, by panning slowly, then recording the same shot again whilst panning much faster. The results seen on playback will be self evident. Make your pans slow and smooth by keeping your feet braced well apart, then by swinging your body slowly, twisting your legs and trunk.

If you require a large panning angle, face your body halfway between the extremities of the pan and start the movement well to the left or right of your frontal position. Always pan much more slowly than you think is necessary, and never pan whilst using a telephoto setting unless the camera is firmly braced.

Keep the subject in focus

Around the outside edge of the lens holder will be seen the focus distance, marked in metres and feet. Focus distance beyond 10 metres is normally shown as "infinity", and all objects between 10 metres and infinity will remain sharp when the focusing ring is set there.

If you set the lens at say, 5 metres (about 16 ft), objects a little closer and a little further away than 5 metres will still be in focus. This in-focus segment is called the "depth of field" and is greater in bright light than in poor light.

If your subject moves closer to or further away from the camera, it may become "out of focus", particularly in modest light conditions, such as are found indoors. You have to be very skilled indeed with your camera to be able to hold the "shot" and change the focus correctly to keep a moving subject in focus. It is much easier to stop recording, re-focus and then start recording again. To retain good continuity for the re-focused shot you should also change your camera angle. More about that aspect of movie making in the next issue.

For zoom lens cameras not fitted with "auto-focus" the procedure for focusing is to zoom right in on the subject, focus the lens by adjusting the focus ring, then zoom back to the lens angle required for the shot, before you start the recording.

This technique is adopted because the depth of field is much narrower at telephoto settings than at wide angle, making the correct focus setting more immediately apparent.

If you have difficulty getting a clear image in the viewfinder, check that the viewfinder eyepiece lens is actually in focus. The viewfinder lens may require the adjustment of a sliding or moveable lever near the eyepiece. Some "auto focus" cameras will not come into focus in unusual light conditions. Read through the camera owner's manual regarding this limitation.

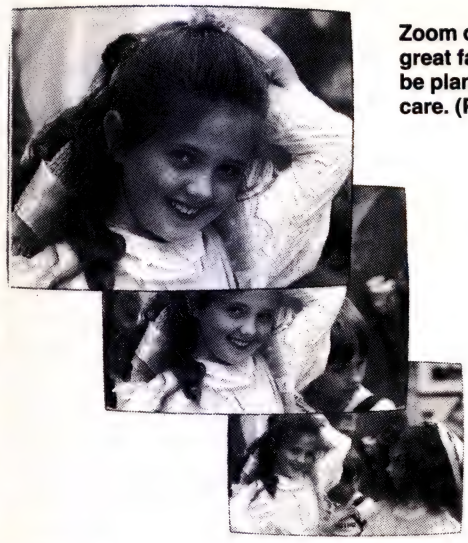
Slow, smooth zooming

Years ago, professional cameramen spoke of the zoom lens with disdain. "Treat it as a pocketful of fixed lenses" they would cry. However, events have overtaken this attitude and cameramen now use the zoom lens frequently, albeit with caution. And the viewing public have become acclimatised to the "zoom" effect.

Unfortunately our consumer type video cameras do not have the magnificent zoom lenses of the TV station cameras, ▷

Typical video camera focus ring and distance scale in metres and feet on the left. To the right can be seen the zoom lever set at a focal length of 12 mm.

Camera control panel for the sophisticated Sony video 8 PRO camera.



Zoom on a camcorder is a great facility, but needs to be planned and used with care. (Pic courtesy JVC).

with their hardly perceptible, silky smooth zoom action. Unless your camera has a slow zoom action, try not to include the zoom effect in your movies. Even operating the zoom lever slowly by hand can spoil the result, with the almost inevitable picture jerk or jump occurring in the middle of the action – or, even worse, causing "visual asthma" by "wheezing" the view in and out.

Zooming out (opening up to a wide shot) is less objectionable to the eye and can occasionally be included in your repertoire. Masking the zoom action in a pan is an effective technique, but it takes practice. To do this you start the pan and the zoom together, both very slowly, such that they will both be completed together as your camera stops to reveal the new scene.

Avoid bright back lighting

Almost all modern cameras have "auto-sense", a facility which adjusts the video gain (or sensitivity) of the camera to suit the scene being taped. When the camera is aimed at a subject which has bright light behind it, such as the sky, the camera "averages" the light value of the whole scene and reduces the video sensitivity lower than that required for the darker subject. The result is loss of detail, and a deepening of the shadow areas.

Some cameras have a manual sensitivity "over-ride" control, often called "iris adjust" or some similar term. Even so, most consumer level cameras do not have internal electronics sophisticated enough to provide good detail of subjects with high back-lighting. They tend to accentuate and blur the edges of the subject and burn out the highlights. Nonetheless, with careful adjustment when setting up the shot, fair results can sometimes be obtained. Better results will be achieved however, if you change the lighting or move the subject or change the camera position.

Avoid distracting background sound

All cameras will have a built-in microphone, which will do a remarkably good job of picking up on-scene sound. Unfortunately they will also pick up unwanted sounds, like the TV set in the next room, the dog barking next door, or just the rumble and thumping of everyday living.

The best way to become aware of this problem is to wear a headset plugged into the "earphone" socket of the camera. You will then hear your sound problems immediately, and be able to counter them in some way. Close the door, shut off the TV, wait for the aircraft to go over, etc.

When outdoors, wind noise may become apparent through your headset, and even though your camera mike may have a foam wind-noise reducer, they are seldom effective in even a light breeze. Moving to a new position to stand with your back to the wind may help, but generally you must put up with the results, or buy an extension microphone with a larger and more effective wind-noise reducer.

An alternative, if the on-scene sound is not required, is to "dub" in some music on to the sound track after the video recording is completed. You will find out more about this editing technique in the next issue.

Video movie making

Operating your camera effectively, by following the guidelines above, gets you over the technical hurdle in home movie making. Stringing a series of shots together to make a viewable whole is where the craft comes in.

Once again the rules are before our eyes most times we watch TV. However we must appreciate that the TV production may be switching between a number of cameras, or editing from shot to shot may have been carried out after the action was filmed or video taped (called Post Production).

Although the home movie maker works with only one camera, certain basic techniques must be followed. This is because over many years of movie watching, audiences have become educated to expect each scene to follow a prescribed formula. A jarring exception to these precepts is found in some "modern" movies which seek to shock by breaking most of the accepted rules, and the results make for disappointed viewing.

Movie making guidelines

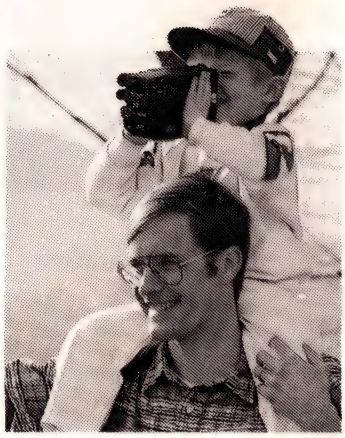
Any movie will be made up of a series of shots or scenes, and these comprise four basic components:-

Wide shot	(WS)
Medium shot	(MS)
Close-up	(CU)
Big close-up	(BCU)

To illustrate each shot, assume a family group of four or five people, standing in line. A wide shot (WS) would take in all of the group. A medium shot (MS) would take in, say, the two people in the centre. A close-up (CU) would show the head and shoulders of one person, and a big close-up (BCU) would show one person's face on the screen.

The interesting aspect of the above list is that each shot can be made with the camera lens set to wide-angle. (Not recommended for close-ups of faces if you want to stay friends with the subject!) To do this requires the camera to move to a new position for each shot, which of course does not have to be in the same sequence shown in the above list.

On the other hand, each of the four types of shots could be made without moving the camera, by adjusting the focal length of the lens (zooming in or out) between each shot.



Today's compact, lightweight, handheld camcorders are fun and very simple to use. It doesn't matter if you've got a one-hand/three-controls "box brownie" model, or a fully featured "pro" machine, the rules for making a successful video are the same. (Pics courtesy JVC)

Shooting sequence

Two similar shots should not follow in sequence, unless the camera angle is changed significantly before making the second shot. If you record a wide shot (WS) of the family group mentioned above, then move the camera just a little to your left (or right) and record another sequence, on playback the scene would appear to jump at the point where the join occurred.

If however you had moved the camera a good distance to left or right to make the second shot, the camera angle would change significantly, and the playback would appear natural. Never move the camera to a new position which would bring it *behind* the subject, as this will disorientate the viewer.

In summary, two similar shots should not follow in sequence unless the camera angle changes significantly. However a series of different shots at the same camera angle can follow each other with natural results.

Varying your shots

A movie comprising a series of wide shots, even if taken from various suitable angles, will have a sameness about it, and it will not grab your audience. In a wide shot scene the point of interest will change, often quite rapidly, and the audience will want your camera to follow this interest.

You have three techniques for following the action.

1. You can zoom in and pan the camera whilst recording, with possible disappointing results when you see the playback.

2. You can stop recording, zoom in and re-focus in a close-up, then re-start the recorder.

3. Or you can stop recording, move yourself in closer with the camera, maybe from a better angle, then re- focus and start recording again.

Of the above options, the third method, if practical, will generally give the best results. However there are some situations where you cannot move your position without disturbing the proceedings, such as when video-taping a wedding ceremony. Strive to position your camera in front and to one side of the happy couple (preferably on the groom's side so as to get a good view of the bride's face), and use a good tripod to keep the camera steady.

Zoom *very* slowly. When in close-up, vary the scene by tilting the camera down occasionally to study clasped hands, the bride's outfit, etc. Stop recording occasionally at appropriate lulls in the service and focus in on members of the congregation, particularly parents and close relatives, to record and capture a variety of facial expressions. Stop recording whilst panning around the congregation, but endeavour to get a cameo of close-ups of faces, interspersed with a wide shot of the whole audience.

Learning from the professionals

Now that you know the basics about camera handling and how a movie is strung together, watch films and documentaries on TV, and dissect them into their parts as they unfold on the screen.

There will be many techniques of little use to the home video maker, most involved with condensing time and making the transition from one place to another. An example of ▷

Figure 2. Three suitable camera positions for use with the lens at wide angle.

(Illustration courtesy Sony)

Video camera fitted on pan and tilt tripod.

both these aspects could be a scene where the Inspector says across his desk to the constable, "Call at 58 Brown Street right away."

The film cuts immediately to a close-up of a front door with a knocker and the number "58" above it. A hand comes into view and raps on the knocker. The tiresome ritual of getting into a police car and driving to Brown Street is thus eliminated.

Pan and tilt tripod showing pedestal extended to quickly adjust camera height.

Close-up of pan and tilt head on the Italian made "Manfrotto" tripod.

What can be learned from the professionals is the art of continuity, although this aspect often becomes disjointed by "soapies", which run four or five stories concurrently. In the main however, good movies and in particular documentaries, will flow at a natural pace – if you don't notice the cuts from scene to scene, then it must be right.

The interview

A basic test for any camera aspirant is to record an interview between two people, using one camera in a fixed position. The camera must be on a good, friction damped tripod to allow slow and smooth movement. Nothing in the recording must distract the viewer's interest from the interview, which means the camera must be absolutely rock steady, or move with perfect coordination.

The problem to solve here is to show the interviewer as the question is posed, and then a close-up of the person replying in order to capture facial expression. The interview normally starts with a "two-shot" of both parties, then pans and zooms very slowly (remember the technique of masking the zoom in the pan) to the person responding to the question.

Anticipating question and reply, changing the shot to create interest, not missing out on the crucial close-up – all these aspects make the "one camera interview" a great test for the budding camera operator.

Unusual camera angles

You can add an interesting variety to your video movie by locating the camera in an unusual position. With the lens set to wide angle, it is possible to carry the camera down low like a shopping bag, having first set the camera to record. Walk along slowly, through crowds on the footpath, or along a beach with the camera pointing slightly away from your legs.

Hold the camera down low, outside the passenger door of a car as it drives along, with the lens pointing slightly away from the car – exercising a generous measure of caution, of course. Place the camera on the road surface to videotape a march or parade. In a crowd, set the camera to record and hold it high above your head, aimed down slightly to the point of interest.

Using a tripod

A tripod designed for still cameras will have pan and tilt adjustments, but it is designed to be used only with the camera stationary. You can set up your video camera on such a tripod to record a family group. Once the camera is recording, you can stroll around and join the group – in other words be "on camera" yourself.

For shooting in the dark, or in low light, a video lamp is the thing. The Unomat range of video lamps are aimed at both amateur and professional users. They are distributed by Kayell Photographic Supplies (02)887 1944.

A tripod designed to allow smooth video camera movement will have the moving parts damped by friction or fluid adjustment. Once your camera is mounted on such a tripod you will be amazed at the silky smooth movement you can achieve. This gives your video movies a real professional touch. A good quality tripod such as described will cost about $250, will last for many years and be one of your best investments.

Practice makes it better

No professional photographer shows you all his pictures, only the good ones. Unless you can edit successfully (see Part 2 next month, on editing) your viewers will see your movie, warts and all. Get your practice in beforehand – videotape is inexpensive and can be used over an over when you are in the "practice mode". Only go public when you have the *best footage "in the can"*.

Glossary

Auto-focus – Lens focusing by electronic sensing of the image.

BNC – Type of coaxial cable plug/socket requiring a push and twist action to engage.

Belling-Lee – Type of coaxial cable plug and socket with push-in action.

Coaxial cable Type of cable used for RF signals. So named because the inner conductor is coaxially located in the centre of the outer copper braid.

Cueing – Positioning the tape to the required position in the recorder. Making a mark or noting a point for later reference.

Cut – The point where one recorded scene stops and the next commences. A clean "cut" causes no disturbance to the picture.

Dub – Originally referred to copying or changing the audio track. Now includes copying a whole video tape programme.

On-scene sound The ambient sound recorded with the picture.

RCA – Type of plug socket with push-in action, with centre pin carrying the signal.

RF – Radio frequency. In video it refers to the combined video and audio signals available on the TV channel frequencies.

Shot – A video scene recorded for a suitable period.

Sync – To synchronise, to prepare two events to occur together.

Zoom – To change the focal length of the lens in a continuous manner. The image appears to come closer (zoom in) or recede (zoom out).

Bonanza in RF components from Dick Smith

Dick Smith Electronics, following a late spring cleanout (like, autumn!), has found they're overstocked on a host of specialised RF components which they're sacrificing at bargain prices, so now's the time to stock up for those projects you wanted to tackle "some day" but couldn't spend the time to hunt out the parts. For amateurs, it's a bonanza!

One of the top bargains is a locally manufactured two-pole, six-position *ceramic* wafer switch with make-before-break contacts. This is a high quality item, with a shielding plate between the wafer sections and generously-sized, high current contacts – and there are *two* pole contacts per wafer, should you need the pole contact in differing positions.

This switch is ideal as a bandswitch in a PA stage, or as a coil tap switch in an antenna tuner/matcher. It could even be used as an antenna selection switch. At $19.95, it's a steal (as they say!). Ask for cat. no. S-6411.

While we're on the subject of antenna switching, another great steal is a coaxial changeover relay with 12 Vdc-operated coil, also for $19.95. This relay is ideal for antenna switching, Tx/Rx switching and works right up to 70 cm. It will comfortably take 150 watts of RF and is known as cat. no. S-7205.

This year, you'll want to make a *big noise* on six metres, right? A pair of Motorola MRF492 transistors will deliver 100 W out from less than 10 W in – and they're great for SSB. At $49.95, you can't lose as they'd normally cost you around $70. Ask for cat. no. Z-9009. They're not easy to blow up and Dick Smith used them in the 100 W 6m Booster kit we published last October.

For that 6m booster amp project then, you'll need some high power mica compression trimmers for the matching networks, won't you. Well, D.S.E. can supply. These top quality "Arco" trimmers cost $5.95, and are available in 130-450 pF (C4210), 95-350 pF (C428) and 55-250 pF (C426), cat. nos. R-9057/58/59 respectively.

Dick Smith Electronics has many other bonanzas in components at present, so pop into a store near you and get amongst it. Or, call **(02)888 3200.**

Trick or tweet

Tweeter-type loudspeakers are vital for crisp high frequency response in your hi-fi speaker systems. If you're building your own system, or you think your old noise boxes need some boosting in the highs, then All Electronic Components have a deal for you.

They are offering an 8 Ohm tweeter with an attractive black crackle finish for only $7.50. The rigid steel surround is 130 mm diameter, and the actual speaker cone is 50 mm diameter. The cone measures just 70 mm across.

All Electronic Components can be contacted on **(03)662 3506.**

Never mind the contents – feel the width!

Philips catalogues are crammed thick (32 mm thick!) with useful data on the full range of Philips products including: logic, memory, analogue, radio, audio and video semiconductors and components, plus tubes, capacitors, resistors and other devices including speakers – and more!

Jaycar has the just-released 1988 edition of the Philips General Catalogue available now for $25. Call in to your local Jaycar dealer, or use the mail order hotline on **(02)747 1888 (in Sydney), or (008)022 088 (elsewhere).**

FAX and RTTY decoders less than $20

Dick Smith Electronics is clearing all stock of the FAX and RTTY decoder kits (cat K-6335) for the CAT or Apple II series of microcomputers.

Originally selling for around $75, the kit is relatively easy to build, and, in conjunction with a shortwave receiver and compatible computer, can display wide-shift commercial radioteletype (RTTY) or facsimile (FAX) weather pictures.

The kits are priced at $19.95, so ring your local DSE store without delay.

N-off or neon?

Neon panel lamps are ideal for showing power status in mains operated devices, or for many other indicator tasks.

All Electronic Components has in stock supplies of the Swann "Series 70" neon lamps in rectangular "snap-in" mounts. These lamps snap-fit in a 10 x 37 mm hole, have a 15 x 40 black bezel, and they're going for one lousy dollar.

An external resistor is needed if the unit is run directly from mains voltage. All Electronic Components can supply both, by mail or in person at **118 Lonsdale St, Melbourne 3000 Vic. (03)662 3506.**

Real-time clock power

Lithium cells for the battery-backed clocks in IBM and similar PCs have not always been easy to find – perhaps because they last so long!

Jaycar Electronics is now carrying stocks of suitable 3 volt lithium cells for $7.95 each. At that price, they work out to a few dollars a year, which is a small price to pay to guarantee accurate log-keeping of your files.

The cell (or battery, if you insist) is type No. CRD 2325, and Jaycar's catalogue number is SB-2530.

PROJECT BUYERS GUIDE

The Versatile Power Supply circuit based on the LM204 should prove quite popular. We're doing several projects around it; this month we're featuring a **'Budget' Power Supply, the AEM2520.** Components are widely available, although the LM204 is not a 'stock' item in the retail chains (yet!). However, kits will be available from Dick Smith stores, Eagle Electronics in Adelaide and All Electronic Components in Melbourne. If you're not taking the kit route, you'll find the LM204 obtainable through Stewart Electronic Components in Melbourne or Geoff Wood Electronics in Sydney.

The SP-6 drivers we used in the **AEM6100 PA Column Speaker** are distributed by Arista, and are widely available. For your nearest stockist, call (02)648 3488. Jaycar carries this speaker as a stock line, cat. no. CE- 2320, as do Eagle Electronics in Adelaide. If you need a line transformer, the Arista LMT-4 is ideal. Again, Jaycar carries this item as a stock line, cat. no. MM-2003, as do Eagle Electronics.

The **AEM4624 Superbis Modem** is available on special offer, through AEM, from Maestro Distributors. See the Special Offer advertisement elsewhere in this issue.

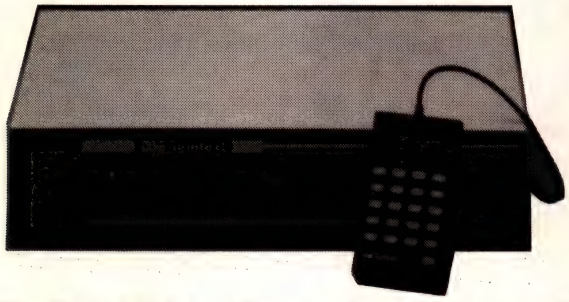
Kits for the **AEM5507 Mains Socket Checker,** featured in our May issue, are now available from Eagle Electronics and Force Electronics in Adelaide, and All Electronic Components in Melbourne. Eagle Electronics is now stocking the Atco plugpack case featured in this project and the AEM9505 NiCad Charger featured in April.

Win these four great Dick Smith kits

Win these first-class kits from Dick Smith Electronics – so good your friends won't believe you built them!

These top-line "high tech" kits will provide the winner with units equivalent to or better than the expensive commercial built-up alternatives, with the priceless bonus of the satisfaction of "doing-it-yourself".

Prizes kindly donated by Dick Smith Electronics; value – almost $1000!

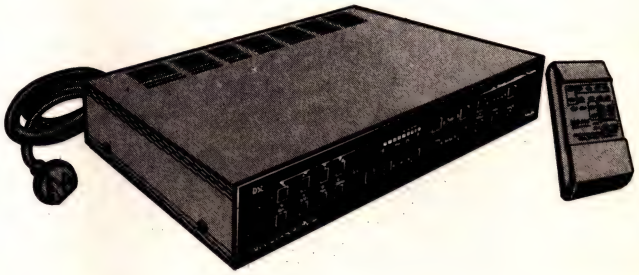


The **K-6315 Teletext Decoder** brings you a wealth of information on your TV screen. The Teletext signal is already being transmitted to millions of homes around the country, carried on the "unused" lines between TV frames and thus normally "hidden". Only those with expensive Teletext TVs, or decoders such as this one can unlock the hidden signals.

News pages and reports on many various activities are broadcast, with one of the most significant services being the provision of captions to popular programmes. This service for the deaf or hearing impaired is available on programmes which display the Caption Centre logo. Do you like a "flutter" on the races? Get your betting information on Teletext!

The Teletext decoder is designed to operate into a standard home VCR, but can be used without one if you build the **Teletext Tuner (K-6319).** This device takes the decoder output and feeds it straight to your TV for no-fuss reception of the teletext material. The kit is simple to build, with very comprehensive instructions, and tuning is a simple matter of selecting the right channel. The tuner can even be built into the Teletext Decoder for maximum utility.

The **K-3437 1 GHz Digital Frequency Meter** provides specifications unheard of in commercial units of only a few short years ago, but with an assembly technique ideally suited to home construction. Frequency measuring range is from 20 Hz right up to a stunning 1000 MHz!



Hi-Fi with maximum convenience is yours with the **K-4003 IR Remote Control Preamp** kit. Not only do you get an eight-input hi-fi preamp with oodles of indicator LEDs and an output suited to most amplifiers, but you get full control over it with a 21-button IR remote control. So sit back, put you feet up and let your fingers do the walking!

---

1) Where in a television transmission is the teletext information located?

. . . . . .

2) Name the last three Managing Directors of Dick Smith Electronics, in chronological order.

. . . . . .

3) What product from Dick Smith Electronics has the catalogue number N-1081 and what other product would you use this with?

. . . . . .

In 25 words or less, why do you want to win these four kits from Dick Smith Electronics?

I have read the rules of the contest and agree to abide by their conditions.

Signature: _____

Name: _____

Address: _____

_____ P/Code: _____

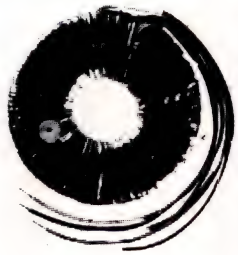
Phone: (___) _____

HI-COM UNITRONICS INT. P/L

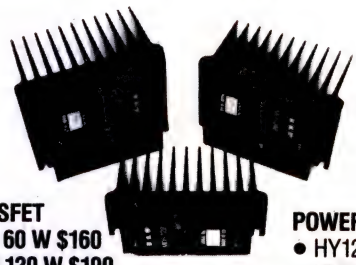
ILP TOROIDAL TRANSFORMER

(Made in UK)

VA	PRICE	DUAL SECONDARY VOLTAGE 6 9 12 15 18 22 25 30 35 40 45 50 55
15	35.50	● ● ● ● ● ● ● ●
30	39.50	● ● ● ● ● ● ● ●
50	45.50	● ● ● ● ● ● ● ●
80	49.50	● ● ● ● ● ● ● ●
120	54.00	● ● ● ● ● ● ● ● ●
160	65.00	● ● ● ● ● ● ● ● ● ●
225	74.00	● ● ● ● ● ● ● ● ● ● ●
300	83.00	● ● ● ● ● ● ● ● ● ●
500	115.00	● ● ● ● ● ● ● ●
625	132.00	● ● ● ● ● ●



POWER BOOSTER AMPLIFIERS



MOSFET
128 60 W $160
248 120 W $190
364 180 W $300

POWER (RMS)
- HY128 60 W **$82**
- HY248 120 W **$105**
- HY368 180 W **$170**

ELECTRONIC COMPONENTS & CABLES — COMPUTER RELATED PRODUCTS

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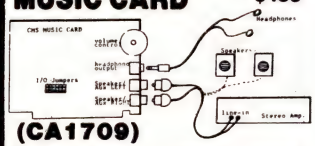
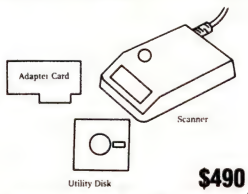
MULTI-USER & MULTI-TASKING SYSTEM ● HARDWARE & SOFTWARE

MUSIC CARD $450

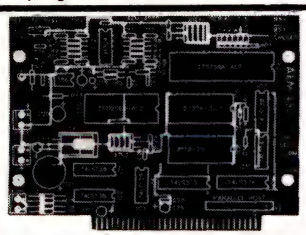


(CA1709)
- Exciting 12 channel stereo music generator with easy to use manual & software.
- Auto rythm/bass etc, with 32 pre-set instruments or decide your own.
- Stereo headphone or speaker output with volume control.

HAND HELD SCANNER (CA1730)



$490
- Scan graphics on to screen with save/load function.
- Easy to use software with edit facilities similar to mouse type programme.



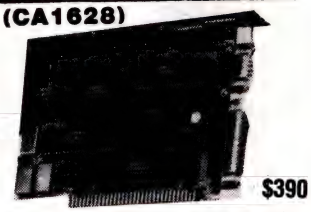
TALK CARD (CA1710)
- Built in code to speech IC's.
- Read any ASC2 files.
- Volume control on speeker
- Software included.
- Available in kit or finished form.

$125 kit **$185 built**

T8255 I/O INT.
- The 8255 I/O card is a programable input-output for PC/XT., This card contains 48 I/O line, 16 LED I/O display, 3 independent 16 bit counters, each with a count rate of up to 2 MHz. All modes of operation are software programmable

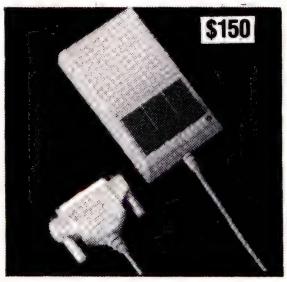
$290

MICRO ENHANCER DELUXE (CA1628)



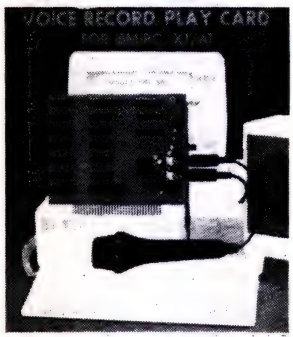
$390
- Drive any monitor, CGA, MGA, EGA, PGA & Multisyn.
- Auto switching up to 700x500.
- Made in the USA.

GENIUS MOUSE V6 CA1736



- Emulate micro soft mouse or mouse system.
- Dr. Halo Graphic & menu maker software.
- Mouse pocket & pad included.

(CA1708)



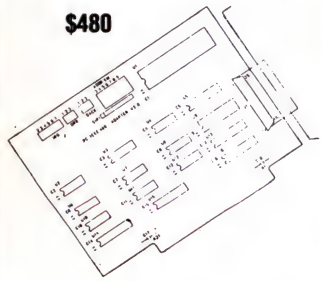
- Record voice or music via mic.
- Save file or diskette or hard disk.
- High quality sound.
- Software listing included for programming.

$199

IEE488 CARD/GPIB

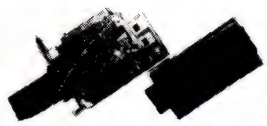
Software package. (Including software, cable & manual).

$480



(CA1702)
The GPIB Software package under BASICA (for IBM PC) consists subroutines which initialize itself as a system controller, talker or listener.

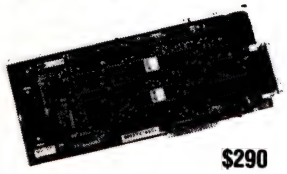
EPROM WRITER CARD



CA3001 **$290**
Direct read/write/copy 2716-27512 eproms with variable voltages to suit different eproms. One external ZIF socket but expandable to 4.

CA3004 **$320**
Same as CA3001 but can copy 4 eproms simultaneously.

12-BIT A-D/D-A CARD FOR PCs



$290

High precision data conversion system. Features 1 channel, 12-bit D-A and 16 channel 12-bit A-D conversion. All on card measuring 320 x 100 mm. With software disk & users manual.
- D-A features 0-9 V output unipolar or bipolar, nonlinearity 0.2%, current settling time 500 ns.
- A-D features input voltage range of 0-9 V unipolar, successive approximation, conversion time 60 us each ch.

HI-COM UNITRONICS

7 President Lane, Caringbah, NSW 2229

P.O. Box 626, Caringbah 2229

MAIL ORDER & RETAIL

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less than $50	$3.50
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$100-$250	$7.00
above $250	$10.00

Heavy items adds extra

PHONE (02) 524 7878 **Visa, Bankcard and Mastercard Welcome**

Economical PA column speaker features special "Bessel" connection

This PA column speaker can be assembled from readily available components for a modest cost. Performance is optimised by the use of a special connection scheme which concentrates the sound output where you want it to go, without the problems that arise with conventional column speakers.

BUILDING YOUR OWN column speakers for a budget PA or sound reinforcement system is a good strategy if you want or need to save on some costs. And the results can be quite satisfying. This project provides a PA column rated at 35 watts and can be assembled for around $100-$120, which is at least half the cost of similar low-cost commercial units.

In addition, the special connection scheme, which we shall explain shortly, while providing the desired sound radiation pattern from the column that resembles a horizontal fan, does not suffer from the high frequency "beaming" that occurs with a standard column. Because of the special connection scheme, this column is known as a "Bessel Array".

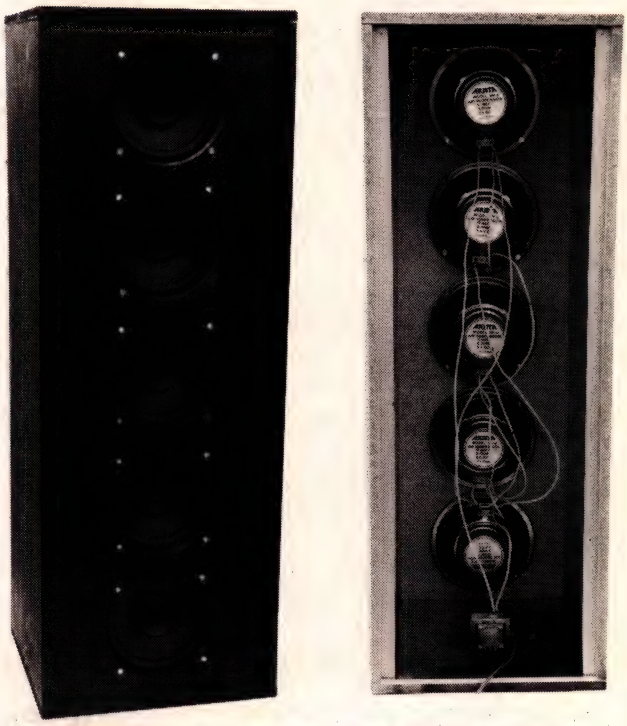
Background

Column speakers date back to the beginnings of the sound motion picture era. The RCA "Photophone" sound system for the early "talking picture" theatres, circa 1928, employed column speakers. They simply put a series of drivers in individual boxes, then stacked them on top of the other. Later, drivers were mounted in a single tall box, in the manner you see here.

Column loudspeakers have been widely used over the years since then, in both indoor and outdoor applications. Stacking of the drivers in a column "compresses" the sound radiation pattern in the vertical plane, but has little or no effect in the horizontal plane. This results in wide horizontal dispersion and narrow vertical dispersion, so that you put more of the loudspeaker's sound output where you need it – horizontally across the audience area, and waste as little as possible vertically, at the same time reducing reverberation effects in indoor venues.

In the latter case, an auditorium which has very reflective ceilings (and many do) can cause considerable problems. Reverberation feedback is a particularly difficult problem to deal with. Reverberation also affects the "quality" of the sound received by the audience. Too much reverberation can confuse and "muffle" the sound. Hence, putting more of the sound where it's needed reduces such problems, or prevents them arising.

The idea of the "Bessel" array was introduced to the 1983 European Audio Engineering Society (AES) Convention in a paper from Philips. We quote: "Bessel panels are simple loudspeaker systems which can produce radially-distributed sound with standard, low-cost speakers. They can be constructed without active or passive components." How's that for getting the "best bang for the buck"!



The project stands just under a metre tall. It's a robust unit that delivers very good results at low cost.

High power PA speakers using a single driver are relatively expensive, and can suffer from distortion owing to the wide cone excursions necessary. Multiple-driver arrays can be expensive, too, and the output is affected by "beaming" at the high frequencies, this effect getting worse the more speakers there are in the column. Thus, sections of the audience will experience some loss at the upper end of the audio range. ▷

LEVEL: We rate this construction project as suitable for:

BEGINNERS

If you've had little or no experience in electronics construction, you should be able to successfully complete this project.

According to the Philips paper, the input to each speaker can be "weighted" according to a mathematical function derived by the German mathematician and astronomer, Friedrich Bessel (1784-1846). Because these weighting factors were fractions, implementing a "real" speaker proved very complicated. However, "Work done at the Philips Research Laboratories has shown that the complications can be eliminated by choosing a weighting factor of 1 for the outer speakers in the row, and higher weighting factors for the inner speakers.

The simplest array employs five speakers, from top to bottom: A B C D E. By choosing a weighting factor of 1, the ratio of the power delivered to each is:

$$A:B:C:D:E = 1:2:2:-2:1$$

This is easier to understand, perhaps, if written as:

$$A:B:C:D:E = 0.5:1:1:-1:0.5$$

Thus, the two outer speakers have to be fed half the power of the others. The minus sign in the weighting factor for speaker D means it has to be connected *in reverse*. Strange, but true!

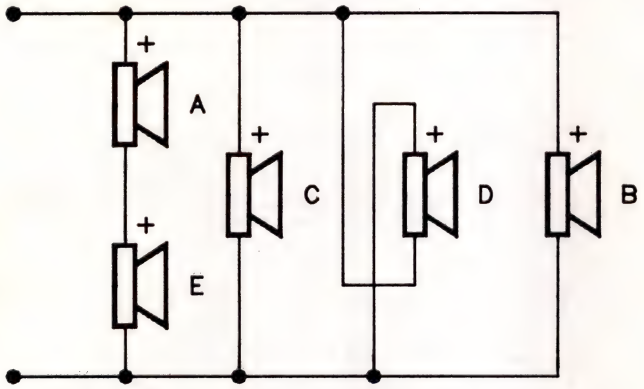


Figure 1. Connecting five drivers in a column to provide the necessary Bessel weighting factors. This is the actual connection system employed in our project.

Connecting-up five loudspeakers to provide the necessary weighting factors is simple – see Figure 1. Note that this is not the only possible connection. Speakers A, B, C could be connected in series and speakers A and E in parallel, connecting these, then, in series with the others. As noted above, speaker D would be connected in reverse.

It's as simple as that!

For a more complete explanation of Bessel panels, see *Sound System Engineering*, by Don and Carolyn Davis, page 327 on, published by Howard Sams.

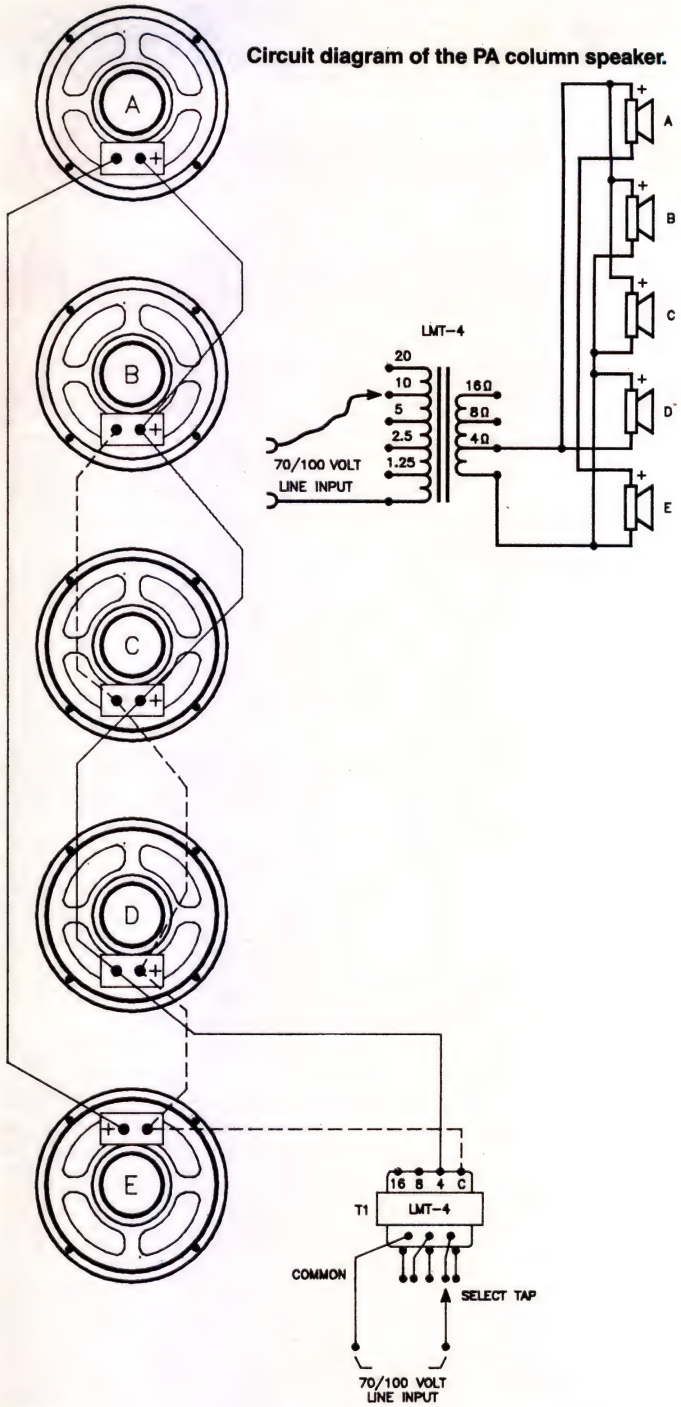
The project

We reasoned that the cabinet had to be made from widely available materials, so 13 mm chipboard shelving was chosen. It fills the bill nicely! It is held together, and braced, with cleats of 10 mm square dressed timber. The front panel is recessed some 10 mm so that a grille cloth may be stretched over a frame and pushed in place for a "friction" fit. However, as choice of grille cloth and driver protection is generally a matter of individual requirements, we'll leave those details to you.

The drivers selected are distributed by Arista, model SP- 6, an 8 Ohm/10 watt 150 mm (6") diameter wide-range twin-cone unit. It is stocked by Jaycar (cat. no. CE-2320), David Reid Electronics in Sydney and Eagle Electronics in Adelaide. Other, similar, drivers are available and would be suitable, but this one was chosen for its wide availability.

The five drivers are mounted as close together as their frames will permit, lined-up on the vertical centre line of the front panel. As the SP-6 drivers incorporate an integral rubber sealing ring around the recessed rim, they are mounted to

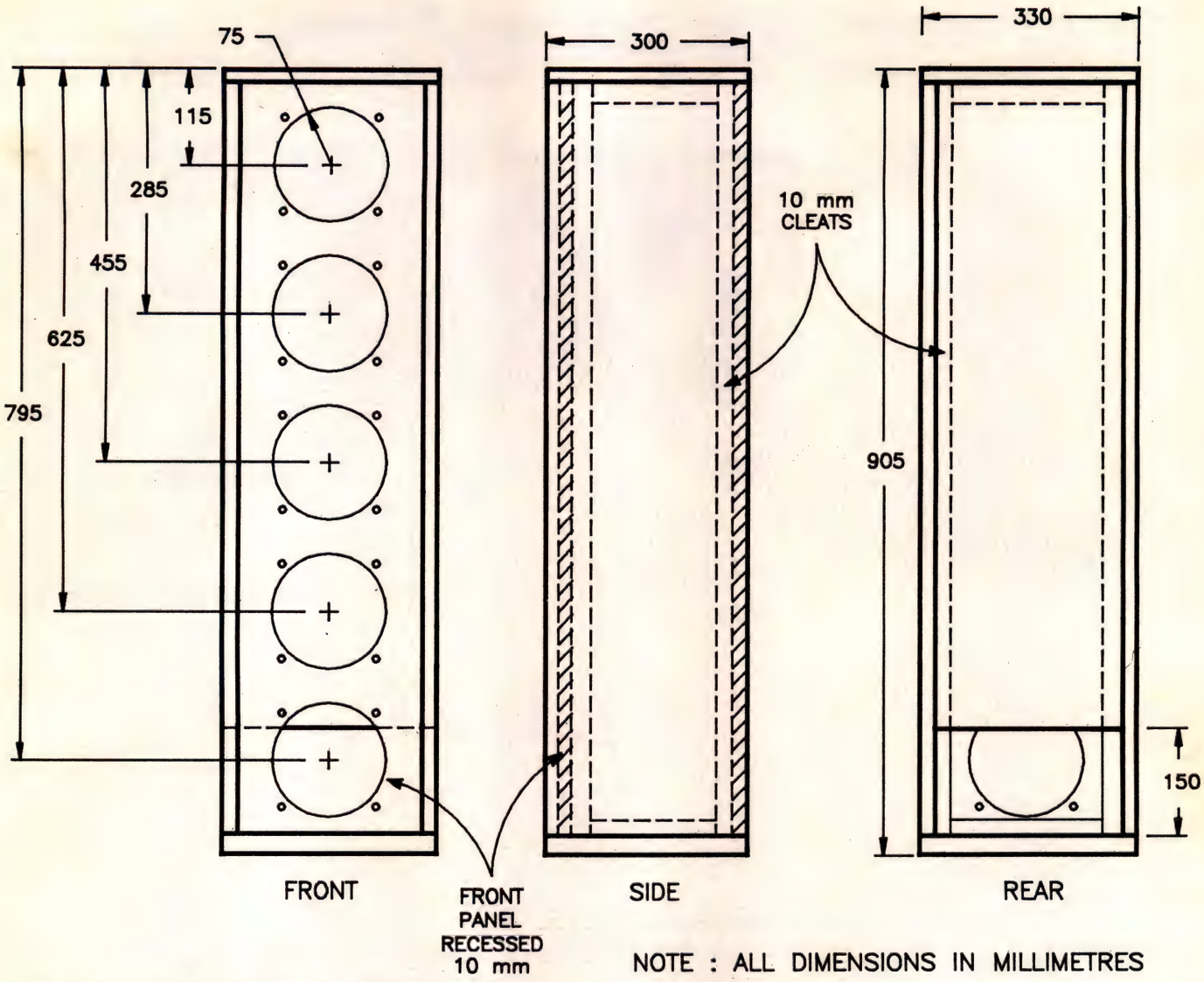
Circuit diagram of the PA column speaker.



Here's how the project is wired-up, including transformer connection details, if you need them.

PARTS LIST AEM6100

5 x Arista SP-6 wide-range 8 Ohm speakers, or similar
2 x 13 mm chipboard shelves, 300 mm wide by 2 m long
1 x 13 mm piece of chipboard, 600 x 300 mm
6 m of 10 x 10 mm dressed timber (cleats)
x Arista LMT-4 multi-tapped 70/100 V line transformer, or similar (optional).
Suitable connectors (your choice)
About 4 m of heavy duty hookup wire
20 x 38 mm (1.5") x 4 mm c/sunk bolts, with nuts & washers
Nails, screws, casein glue (e.g: Aquadhere), etc



Cabinet. Material is 13 mm chipboard. We used lengths of pre-cut shelving.

the rear of the front panel. The cabinet may be dressed by painting it (we sprayed ours), or covering it in a durable cloth, adding corners and mounts, as required.

Some internal sound deadening was effected with 50 mm high density foam rubber, obtained from specialist rubber products suppliers. It was simply folded lightly and stuffed in the cabinet just before screwing the back panel in place.

Because many PA sound systems employ "70 V" or "100 V" line distribution systems, which eliminate the losses inherent in low impedance lines, we suggest the addition of a suitable 70/100 V line multi-tapped transformer, such as the Arista LMT-4. This allows "matching" of the speaker, for maximum output, or "tapping down" to adjust the sound level, as required.

As the impedance of the speaker system wired this way work out at around 2.3 Ohms, matching to four or eight Ohms may be necessary if they are to be driven directly, depending on the output rating of your PA sound system's amplifier. The LMT-4 can be employed in an auto-transformer configuration in such cases. Connect the driver array across the 4 Ohm tap. The 16 Ohm tap then provides a roughly 9 Ohm impedance, while the 8 Ohm tap provides an impedance input of between four and five Ohms. Note that the transformer is rated at 20 watts.

Construction

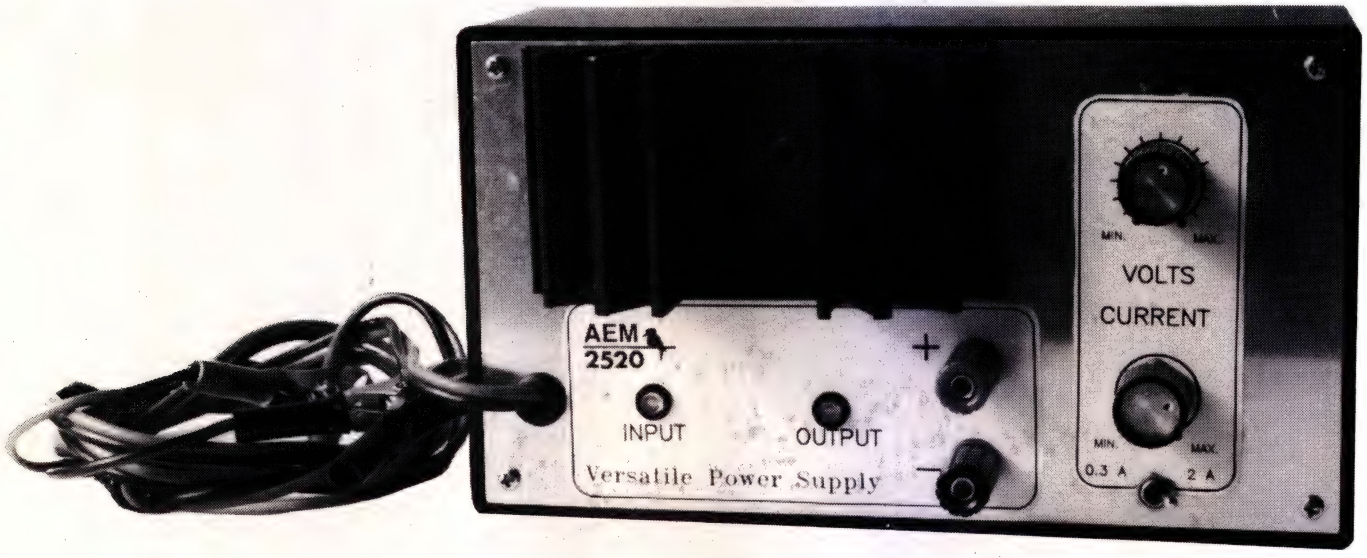
Assembly is quite straightforward, particularly if you've had a modicum of experience with carpentry. The diagram here shows all the dimensions.

Cut the sides, front and rear panels, then the top and bottom pieces. Cut the cleats to size last. Note that the rear panel is cut 150 mm short. This is to allow some internal access, and to mount the required connectors. Chipboard is generally too thick for this, and it's best done with a metal plate or piece of plywood.

Mark out the front panel next. Do this carefully and you'll avoid frustrating mistakes. Not that the holes should be just large enough to provide clearance for the speaker cone rim suspension, to leave enough material for the speaker mounting holes. The holes may be cut with either a router (as we did), or a jigsaw. Some filing with a half-moon file should be necessary to clean up the cuts. A speaker can then be used to mark the rim bolt hole positions. Carefully drill these holes to clear the mounting bolts, and then countersink them (on the front face, remember!).

Mark out and nail or screw the cleats in place on the side panels, running a bead of glue down the joining face of each cleat first. Assemble the top and bottom panels, running a

• to page 80 ▷



A 'budget' bench supply

Jonathon Scott
Brereton Samuel Research Pty Ltd

This project, our first based on the Versatile Power Supply circuit, is a 'basic', low-cost variable power supply that may be powered from ac (a suitable transformer) or dc (a battery), and is ideal for the enthusiast's workbench or in the service workshop.

AS DETAILED elsewhere in this issue, we are presenting a number of construction projects based around a novel and ingenious power supply circuit not previously published. This first one is a straightforward power supply for the experimenter's bench or service workshop, featuring continuously variable output voltage and variable current limiting. No output metering has been included in order to keep costs down – your multimeter can be used here! The second project, to be presented next month, is devoted to producing this power supply in a mains-powered configuration and incorporating full metering, as well as supplementary projects, two protection modules, making it a fully-fledged 'lab.' supply.

But first, let's build the basic supply module. The AEM2520 project is a fully adjustable dc power supply which can take its input from almost any supply – either ac or dc – ranging from 10 Vdc volts to a maximum of 40 – 50 Vdc, or about 8 Vac to a maximum of 35 Vac (see 'Using the 2520'). The output current limit is continuously variable up to the maximum, which is in excess of two amps. The output voltage is likewise continuously variable, down to effectively zero volts.

The general principles of the circuit and the project are covered in more detail in a separate introductory article elsewhere in this issue.

Being a 'budget' project, a jiffy box with an aluminium lid was used to house it. As it may be powered from either ac or dc, "flying" input leads are used to connect the unit to whatever source – transformer or battery – you might employ.

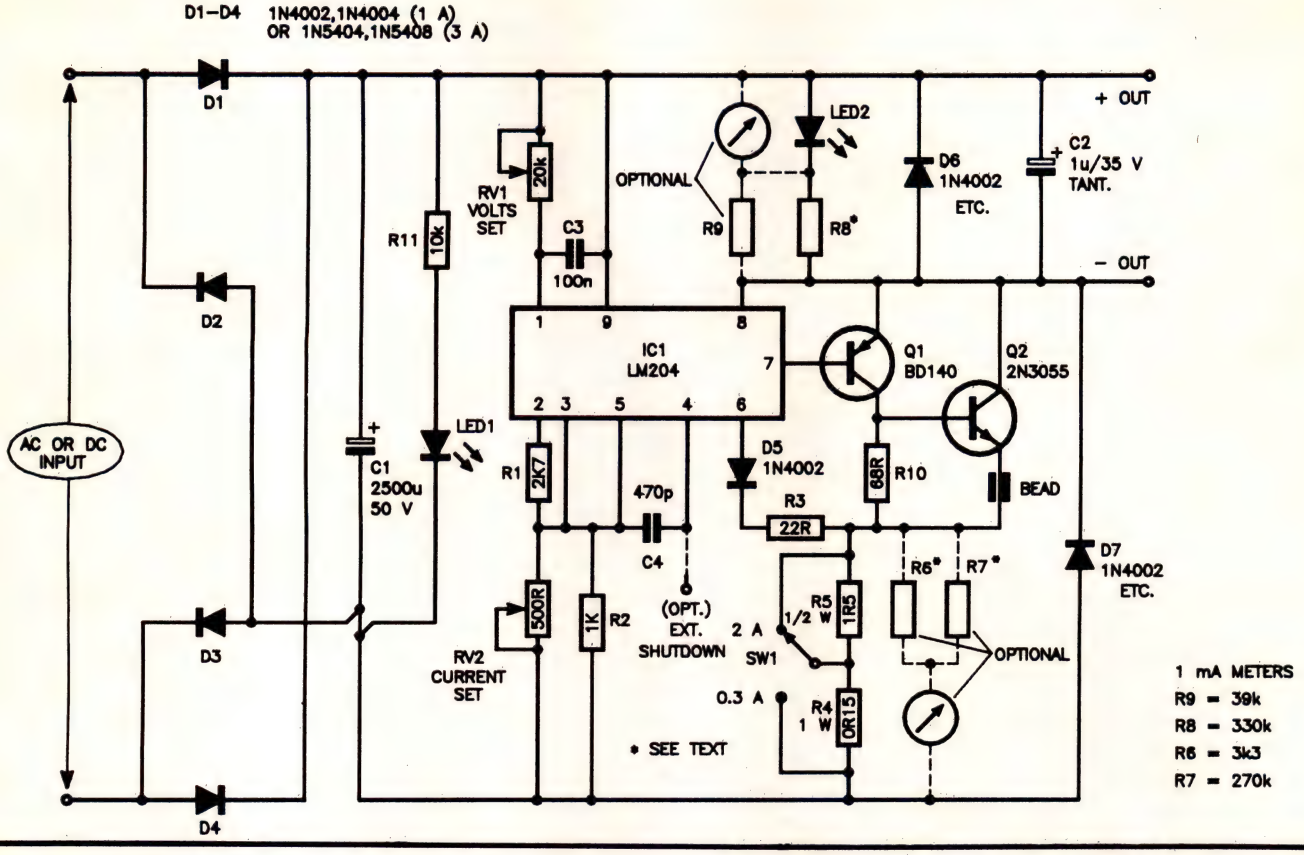
The project is housed in a commonly available jiffy box. Scotchcal labels are used to dress up the front panel and provide annotation for the controls, etc.

Construction

This procedure is relatively straightforward once you have the printed circuit board. It is not advisable to build this circuit on anything else, such as Veroboard or matrix board, unless you're well experienced in electronics assembly. The pc board substantially reduces the possibility of wiring errors, and obviates other problems.

SPECIFICATIONS as measured on the prototype.

Output Voltage Range:	0.015 V to 37 V with 40 V input. 0.008 V to 17 V with 20 V input.
Current Limit Range:	<30 mA to >300 mA (range 1) <250 mA to >2 A (range 2)
Load Regulation:	<0.01% at 100 mA load. Below 40 mV, zero to 2 A.
Line Regulation, dc:	<0.05% all conditions, overhead >3 V.
Line Regulation, ac :	Ripple signal 1 mV p-p at 500 mA. PSRR approx 0.1%.
Output Noise:	approx 0.6 mVrms, dc – 100 kHz.
Quiescent Current:	2 mA, plus current for LEDs (3.5 mA typically)



CIRCUIT OPERATION

This supply is based around the LM204/304 negative regulator IC. Here we describe the function of the IC, and the purpose of all the components in the circuit. The IC has a number of functional parts: A current reference generator, a comparator, a driver amplifier and a current shutdown circuit.

A constant current is fed out of pin 1 of IC1, through RV1 to the positive incoming rail. According to the resistance setting of RV1, some voltage is dropped across it. The current is temperature compensated and thus the voltage dropped across RV1 at any particular setting is very constant. This constant current is set by R1.

The constant current, plus a little overhead current used by the current generator circuitry within IC1, is also passed through the combination of RV2 and R2 in parallel. Thus a fairly (but not rigidly) constant voltage is developed at the junction of R1 and R2 with respect to the other power supply rail, this time the negative one. The constant voltage developed by RV1 will be used to set the output voltage, and the voltage set by RV2 to determine the maximum deliverable output current.

A comparator circuit, again within IC1, looks at the voltage on pin 1 and also on pin 8, which is connected to the output of the regulator circuit as a whole. It then controls the driver circuit to set these two equal, thus copying the constant voltage dropped across RV1 to the load. This achieves very good output voltage regulation, since the comparator has significant gain. (It is really just an op-amp.)

The driver circuit feeds current out of pin 7 in an attempt to pull pin 8 *lower* when the comparator senses that more output voltage is required. This turns on Q1 more. As the current drawn by Q1 increases, the voltage dropped across R10 increases. As the current exceeds about 10 mA, sufficient voltage is dropped across R10 to turn on Q2.

Transistors Q1 and Q2 are connected as a "Szilikai pair", which is like a Darlington pair, except that the transistors are of opposite polarity (pnp-npn). This has the advantage that no more than one Vbe drop is needed between pins 7 and 8, which serves to keep the voltage overhead (sometimes called the voltage burden) of the regulator as low as possible. The disadvantage is that the combination is more prone to instability than a Darlington arrangement, and thus the bead in the emitter of Q2 is required to maintain stability by introducing a high frequency impedance in the emitter of Q2 to degenerate it.

The driver circuitry also has its current used doubly, as did the constant current generator.

The current drawn by Q1 via pin 7 is fed out of pin 6. Now IC1 normally looks to see if the voltage on pin 6 has risen more than one diode drop above that on pins 3 and 5, which are expected to be connected directly to the negative rail. This arrangement is fine, but does not allow for varying the limit current, but fixes it as one Vbe drop across the current sense resistors.

We have arranged to fix pins 3 and 5 at a potential set by RV2. We have added R3 and D5 to cancel the diode drop inside IC1. The load current drawn via pin 7, Q1 and Q2 is passed through a current sensing resistance, selected by SW1 to be either 1.5 or 0.15 Ohms. The voltage dropped across these resistors is thus directly compared with the voltage set across RV2, and the drive shuts down if the latter is exceeded by the former. Should current metering be required this voltage provides it.

Having SW1 select one of two resistors for the sense resistance allows there to be two current ranges, in this case, one up to about 2 amps, starting at about a quarter of an amp, and the other one order of magnitude lower.

Diode D6 provides protection against external voltages being connected backwards across the output terminals. D7 protects IC1 from externally applied voltages while it has no supply. Resistor R3 allows the current limit to work earlier should Q1 and Q2 saturate, thus protecting the driver circuitry in IC1. Capacitor C4 compensates the op-amp inside IC1.

We have used R2 in parallel with RV2 to set the maximum current limit more exactly.

Finally, C3 removes voltage spikes and noise from across RV1, which prevents such noise and spikes from appearing at the output.

We have put a bridge rectifier and filter capacitor, D1-D4 and C1, in front of the regulator so that the supply can use either ac or dc inputs (of either polarity) for its source.

Capacitor C5 is placed across the output to keep the high frequency output impedance low, and the supply stable with large loads and long leads, but its value is small enough to limit the energy available before current limiting can act to less than one millijoule.

The availability of high efficiency LEDs permits the use of two of them as input and output voltage indicators, without seriously reducing the power economy of the circuit.

Resistors R11 and R8 are selected to obtain good brightness with modest input voltages for LEDs 1 and 2.

PARTS LIST AEM2520

Semiconductors

Q1 . . . . . BD140, etc
Q2 . . . . . 2N3055
IC1 . . . . LM204/304 (see text)
D1-D4 . . . . . EM401/2/4, 1N4001/2/4,

or 1N5404 (see text)
D5-D7 . EM401/2/4, 1N4001/2/4

LED1, 2 . . high efficiency LEDs

Resistorsall 1/4 W, 5% unless noted

R1 . . . . . 2k7 1/4 W or 1/2 W
R2 . . . . . 1k
R3 . . . . . 22R
R4 . . . . . 0R15, 1 W or 5 W
R5 . . . . . 1R5, 1/2 W
R6, 7, 9 . . . . . used only with metering
R8 . . . . . 10k
R10 . . . . . 68R
R11 . . . . . 10k
RV1 . 20k/A lin. panel mount pot
RV2 . . . . . 500R/A lin. panel mount pot

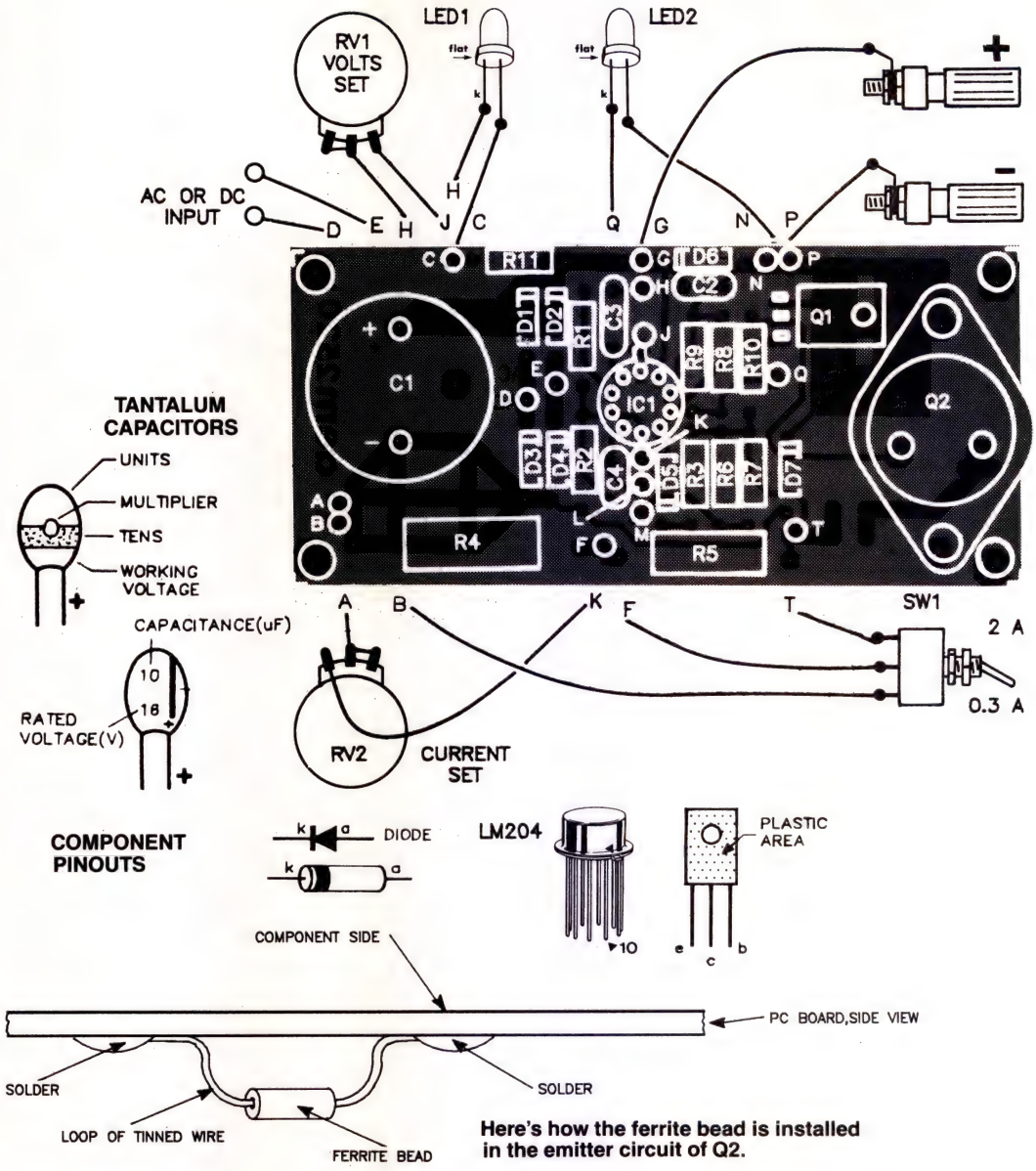
Capacitors

C1 . . . . 2500u/50 V RB electro.
C2 . . . . . 1u/35 V tant.
C3 . . . . . 100n (0.1u)greencap (poly)
C4 . . . . . 470p ceramic

Miscellaneous

AEM2520 pc board; ferrite bead; jiffy box – 190 x 110 x 60 mm; knobs to suit pots; heatsink – 100 x 50 mm; two screw-type terminals; SPDT toggle switch; two large alligator clips; two LED mounting bezels; one grommet; panel label; aluminium bracket; insulating washers for Q1 and silicone heatsink compound; heavy duty cable; hookup wire; tinned copper wire; nuts and bolts, etc.

Estimated cost: $55- $60



Here's how the ferrite bead is installed in the emitter circuit of Q2.

Following normal practice, begin with the metalwork. The first step is to mark out and drill the front panel of the jiffy box. You can use the front labels reproduced here (or provided with your kit) as a template for this. The panel is soft aluminium and is thus easily torn or warped.

Mark all hole centres with a scriber or pen, then either use sheet-metal drills, or drill small (around 3 mm) pilot holes and then expand them to the required diameter with the appropriate drill. A hand-operated tapered reamer, (available from the larger electronics retailers), does a very good job of enlarging holes in sheet metal, if it is used gently. It is a good idea to clean the sharp burrs from the holes after drilling with a cleaning tool or an oversized drill. This will protect your fingers and the front panel label later.

Next, use the panel itself as a template to mark where the holes should go in the heatsink. The heatsink position is not critical, except that it must not interfere with other things on the panel, including the screw which will hold the panel to the plastic part of the box. Drill the heatsink next.

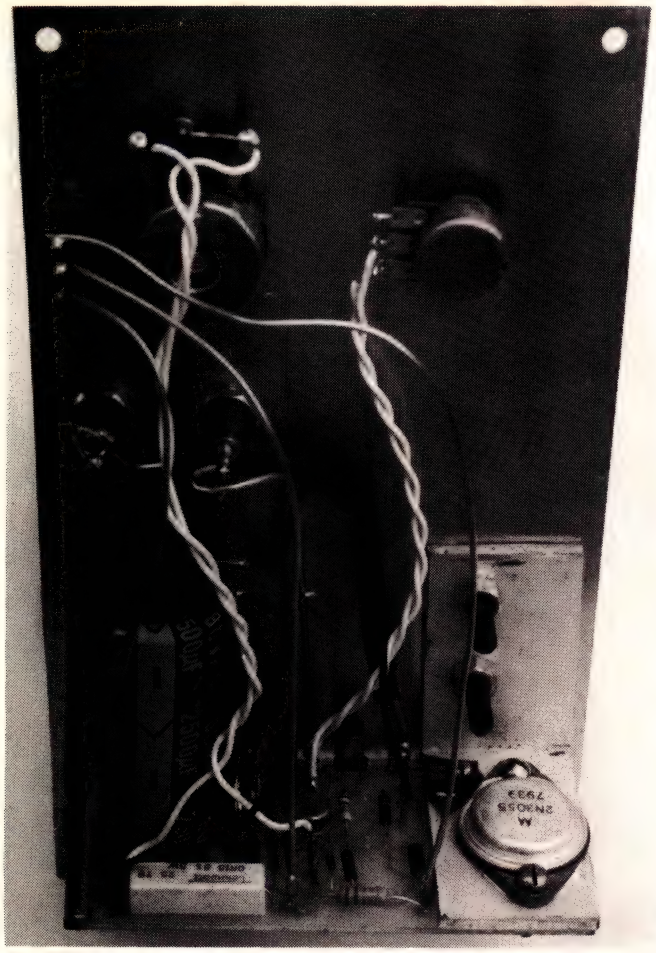
Now cut out the bracket to mount the printed circuit board to the panel/heatsink. We used a small section of 3 mm aluminium extrusion, but any metal of this or greater thickness will do. The size of the bracket is not critical, save that it must fit in the box when closed, and it should be wide enough to take Q2, and be as long as the pc board is wide.

Use the blank pc board to mark where the holes need to go on the heatsink bracket to take Q1 and Q2. Likewise, use the panel to mark where the holes in the bracket must go so that, in turn, it can be bolted to the panel and the heatsink. This order of marking will ensure that all the holes finish up compatible.

With the panel prepared, you can now place the two Scotchcal labels on the panel. This is more easily accomplished if your first soak each label in water and wet the panel with a sponge before placing the label on it. The glue is water-soluble and this allows the Scotchcal labels to be moved a little to enable correct positioning. Sponge off excess water when the labels are in place.

Now mount all the components on the panel except the bracket: The terminals, the LEDs, the pots (with their knobs), the switch and the grommet in the cable entry hole. The high efficiency LEDs that we have used came, as they mostly seem to, with clear plastic lenses, rather than translucent ones. If you wish to widen the viewing angle, you should roughen the lenses. Simply use some 180-grade abrasive paper or a file to flatten the rounded end of the LEDs' case.

Now turn your attention to the pc board. It is perhaps better to fit the heatsink bracket and Q1 and Q2 first. The case of Q2 does not need to be insulated from the bracket, as the case, which is the collector, is at output negative potential. It does, however, need to have adequate thermal conducting paste applied, since Q2 may have to dissipate a lot of energy.



This picture shows how the wiring between the pc board and the external components is completed.

Note that Q1 requires insulation. First check that there are no burrs or metal filings left from the drilling. Then apply a small amount of paste to the bottom of Q2 between the base and emitter pins and gently seat it in its place on the bracket. Put the pc board in position under the bracket and fit the two bolts to hold the three together.

Fit Q1's legs through the pc board holes, apply some paste to its underside, and also some to the heatsink. Sandwiching the insulating washer between the heatsink and Q1, bolt the three to the pc board. Tighten the bolts and solder the transistors in place.

Fit the remaining components to the pc board. A place for C1 is made on the pc board, but if you wish to use a chassis-mounted capacitor, or you cannot get the large "RB" type capacitor, there is no special need for it to be pc board mounted. If an off-card component is used, be sure to run relatively heavy wires, say of at least 1 mm diameter, since the full load current must be drawn through them, and ripple specification depends upon the low resistance of the connection. Make certain the polarised capacitors, diodes and IC are oriented correctly.

We fitted small posts to the pads to which flying leads are to be run in order to simplify the final wiring-up. It is best to fit the ferrite bead for Q2's emitter lead last. This is because it is brittle, and a careless drop could harm it. It is simply threaded on a short piece of wire and the wire soldered to the two copper-side pads. The type of wire is not important.

A note concerning IC1. We have specified an LM204, which is an "industrial grade" device, and a couple of dollars more expensive than the plain "commercial" LM304. This specification is to enable the supply to work up to a full 50 volts on the input. The 304 device is only guaranteed to 40 volts. There is no other specification difference of any concern here, so you can use a 304 if you do not need to run over 40 volts on the input.

LEVEL: We rate this construction project as suitable for constructors of:

INTERMEDIATE

experience, between beginners and experienced constructors, with experience in building a number of projects of differing complexity.

I should also say something about the input diodes, D1 to D4, at this stage. If you're using a 1 A rated transformer as a source, and don't intend using more than 1 A output current, use 1N4001-1N4002 series diodes which are rated at 1 A. Otherwise, use 1N5404 diodes, which are rated at 3 A.

Positions have been left on the pc board for resistors associated with panel voltage and current meters. In this project the cost and inherent fragility of panel meters is not really justified. Simply leave the spaces blank. If you wish to fit meters, the method of obtaining the correct resistor values will be explained when the second version (AEM2521) of the supply is described.

When all the components have been fitted and soldered in place, it is time to bolt the pc board and bracket onto the front panel.

Check the positioning of the pc board behind the panel. You will probably have to bend the LED wires inwards to get clearance for C1. Again, use thermally conductive paste, both between the panel and the bracket and between the panel and the heatsink. When you tighten the bolts, small amounts of the paste should squeeze out of the join, indicating that sufficient has been applied.

Now run all the flying leads. We recommend using heavy duty cable for the input wires; 3 mm diameter automotive cable is quite satisfactory, as is heavy duty "loudspeaker" wire. Solder some suitably heavy duty alligator clips to the cables, and run the end through the grommet. Secure the cable. We simply tied a knot in it, and although purists say that this may harm the cable, it seems most unlikely with automotive cable. Because the supply has a bridge rectifier in it, the polarity of the input is unimportant, and the wires need not be colour-coded.

Run leads to the other items on the panel. Again, heavy duty connections are recommended to the terminals, and to the current range selection switch. We used 1.2 mm tinned copper wire in the prototype, with a little spaghetti insulation where required. This is rigid, and is easily positioned safely so that it cannot short out onto the panel (which is at output negative potential).

The pots, especially the current limit one, should *not* be wired rheostat-style (one end open-circuit, using only the wiper and the other end). This is simply because momentary losses of connection which could arise with age in the pots could briefly disable the current limiting circuit. Capacitor C3 has been included to provide smooth adjustment of the voltage even with a "scratchy" pot.

After fitting all the flying leads, the device is ready for testing. Connect some input voltage and see that the power LED comes on. Check that the output LED comes on when the output is turned up. If you connect a short circuit and turn up the current limit control, the supply should eventually become very hot. Check that the heatsink gets hot too. It will actually become too hot to touch after a couple of minutes!

Using the 2520

Using this power supply is like using most others, with just a few interesting points added, which arise because of it's versatility. This section is included for those who might like to have a few of the techniques for correct use of any 'lab.' supply explained.

• to page 80. ▷

Voltage Regulators

LM104/LM204/LM304 negative regulator general description

The LM104 series are precision voltage regulators which can be programmed by a single external resistor to supply any voltage from 40V down to zero while operating from a single unregulated supply. They can also provide 0.01-percent regulation in circuits using a separate, floating bias supply, where the output voltage is limited only by the breakdown of external pass transistors. Although designed primarily as linear, series regulators, the circuits can be used as switching regulators, current regulators or in a number of other control applications. Typical performance characteristics are:

- 1 mV regulation no load to full load
- 0.01%/V line regulation
- 0.2 mV/V ripple rejection
- 0.3% temperature stability over military temperature range

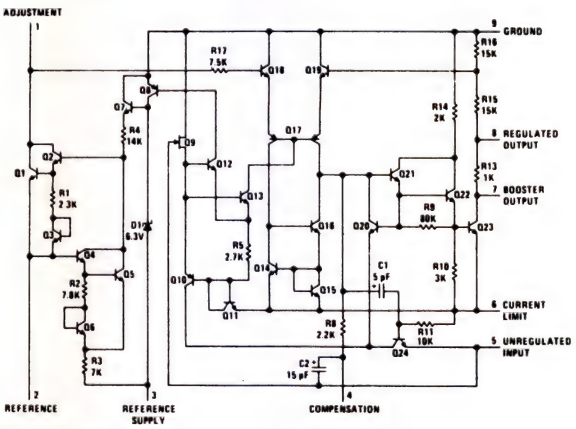
The LM104 series are complements of the LM100 and LM105 positive regulators, intended for systems requiring regulated negative voltages which have a common ground with the unregulated supply. By themselves, they can deliver output currents to 25 mA, but external transistors can be added to get any desired current. The output voltage is set by external resistors, and either constant or foldback current limiting is made available.

The LM104 is specified for operation over the −55°C to +125°C military temperature range. The LM204 is specified for operation over the −25°C to +85°C temperature range. The LM304 is specified for operation from 0°C to +70°C.

absolute maximum ratings

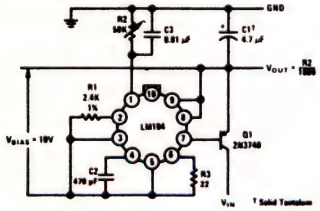
	LM104/LM204	LM304
Input Voltage	50V	40V
Input-Output Voltage Differential	50V	40V
Power Dissipation (Note 1)	500 mW	500 mW
Operating Temperature Range		
LM104	−55°C to 125°C	
LM204	−25°C to 85°C	
LM304		0°C to +70°C
Storage Temperature Range	−65°C to 150°C	−65°C to +150°C
Lead Temperature (Soldering, 10 sec)	300°C	300°C

schematic and connection diagrams

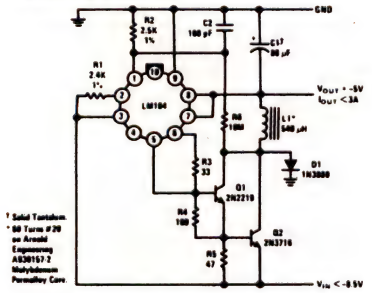


typical applications

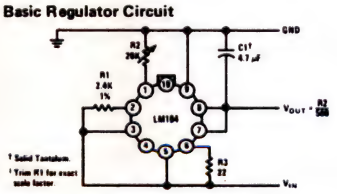
Operating with Separate Bias Supply



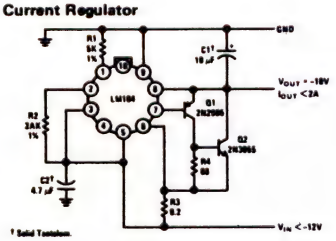
Switching Regulator



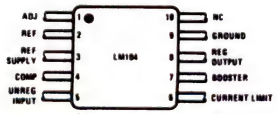
Basic Regulator Circuit



High Current Regulator



Flat Package



Note: Pin 5 connected to bottom of package.
TOP VIEW
Order Number LM104F, LM204F or LM304F
See Package 3

Metal Can Package

Note: Pin 5 connected to case.
TOP VIEW
Order Number LM104H, LM204H or LM304H
See Package 12

electrical characteristics (Note 2)

PARAMETER	CONDITIONS	LM104/LM204			LM304			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Voltage Range		−50		−8	−40		−8	V
Output Voltage Range		−40		−0.015	−30		−0.035	V
Output-Input Voltage Differential (Note 3)	I_O = 20 mA	2.0		50	2.0		40	V
	I_O = 5 mA	0.5		50	0.5		40	V
Load Regulation (Note 4)	$0 \leq I_O \leq 20$ mA, $R_{SC} = 15\Omega$		1	5		1	5	mV
Line Regulation (Note 5)	$V_{OUT} \leq -5V$, $\Delta V_{IN} = 0.1\ V_{IN}$		0.056	0.1		0.056	0.1	%
Ripple Rejection	$C_{19} = 10\ \mu F$, f = 120 Hz, $V_{IN} < -15V$		0.2	0.5		0.2	0.5	mV/V
	$-7V \geq V_{IN} \geq -15V$		0.5	1.0		0.5	1.0	mV/V
Output Voltage Scale Factor	R_{23} = 2.4k	1.8	2.0	2.2	1.8	2.0	2.2	V/kΩ
Temperature Stability	$V_O \leq -1V$		0.3	1.0		0.3	1.0	%
Output Noise Voltage	10 Hz ≤ f ≤ 10 kHz, $V_O \leq -5V$, $C_{19} = 0$		0.007			0.007		%
	$C_{19} = 10\ \mu F$		15			15		μV
Standby Current Drain	I_L = 5 mA, $V_O = 0$		1.7	2.5		1.7	2.5	mA
	$V_O = -30V$					3.6	5.0	mA
	$V_O = -40V$		3.6	5.0				mA
Long Term Stability	$V_O \leq -1V$		0.1	1.0		0.1	1.0	%

Note 1: The maximum junction temperature of the LM104 is 150°C, while that of the LM204 is 125°C and LM304 is 100°C. For operating at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of 150°C/W, junction to ambient, or 45°C/W, junction to case. For the flat package, the derating is based on a thermal resistance of 185°C/W when mounted on a 1/16 inch thick epoxy glass board with ten, 0.03 inch wide, 2 ounce copper conductors.

Note 2: These specifications apply for junction temperatures between −55°C and 150°C (between −25°C and 100°C for the LM204 and 0°C to +85°C for the LM304) and for input and output voltages within the ranges given, unless otherwise specified. The load and line regulation specifications are for constant junction temperature. Temperature drift effects must be taken into account separately when the unit is operating under conditions of high dissipation.

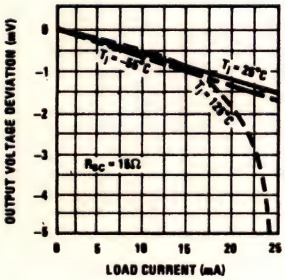
Note 3: When external booster transistors are used, the minimum output-input voltage differential is increased, in the worst case, by approximately 1V.

Note 4: The output currents given, as well as the load regulation, can be increased by the addition of external transistors. The improvement factor will be roughly equal to the composite current gain of the added transistors.

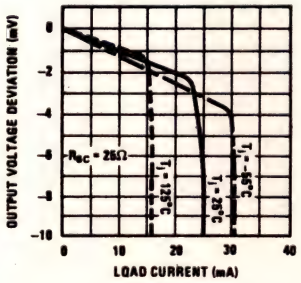
Note 5: With zero output, the dc line regulation is determined from the ripple rejection. Hence, with output voltages between 0V and −5V, a dc output variation, determined from the ripple rejection, must be added to find the worst-case line regulation.

typical performance characteristics

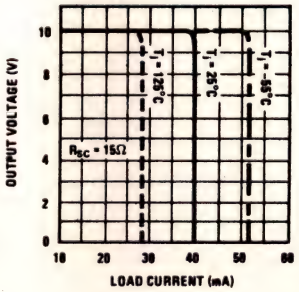
Load Regulation



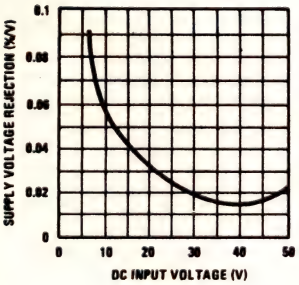
Load Regulation



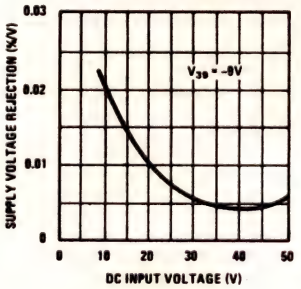
Current Limiting



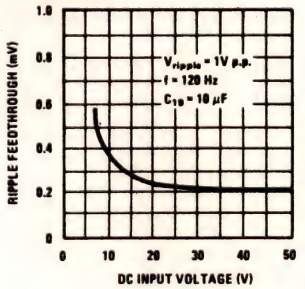
Supply Voltage Rejection



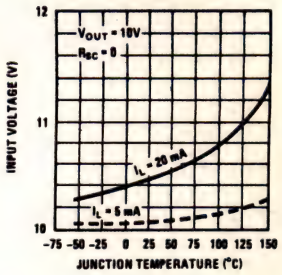
Supply Voltage Rejection With Preregulated Reference Supply



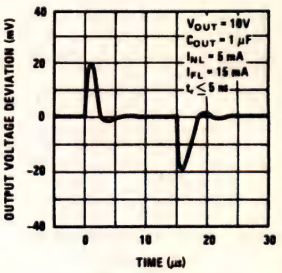
Ripple Rejection



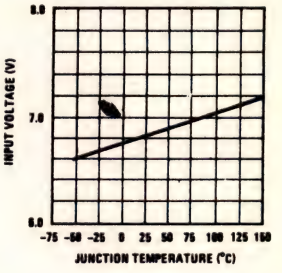
Regulator Dropout Voltage



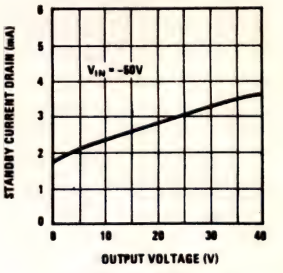
Load Transient Response



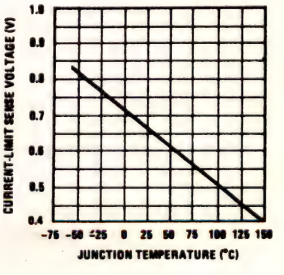
Minimum Input Voltage



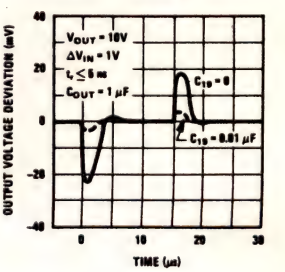
Standby Current Drain



Current Limit Sense Voltage



Line Transient Response



The SUPERbis modem

Part 3 – final construction and testing steps

Roy Hill

This article outlines the suggested procedure for fault-finding and trouble-shooting the completed unit and details some last minute circuit modifications. As a bonus, Roy will present a fourth article next month on additional ways of controlling the modem outside your comms package.

BEFORE WE START the testing procedure, there are several items that must be completed on the circuit board. The first of these is the coax trace that we installed to take the Rx signal to the "rxc" point on the immediate right of T1. Because only the centre wire is connected at this point, it is necessary to isolate the shield from shorting against the transformer, or other components. A blob of silicone adhesive will prevent any shorting from occurring. An alternative to silicone is heat shrink tubing over the trace.

The speaker must be mounted in the lid of the case and Maestro provide a mounting bracket in the kits for this purpose. A flying lead runs from the speaker to connector P5 on the front right hand side of the board. The connector pins for this are supplied and a length of twin conductor wire will be necessary to connect to the speaker. Leave sufficient lead length to allow the lid to lie alongside the case with the speaker connected, whilst the modem is operating.

The Telecom plug is connected to the Utilux pins at the front left hand side of the board. *Do not* connect the Telecom plug at this stage.

Circuit modifications

There have been several performance improvements made to the board since the last article was written. Whilst these alterations are only of a minor nature, they could be important to someone performing circuit analysis or trouble- shooting procedures.

IMPORTANT – Because of the modifications to the circuit, it is *absolutely vital* to read these notes and to check off the parts against the parts list included with the kit.

The 74LS138 and the 74HC133 no longer exist – their functions have been replaced by other chips. The selection of the Digital Signal Processor (DSP) circuit is now accomplished by control of the DM line only, using a spare AND gate on U16. The manner in which U14 (74LS153 multiplexer) is configured has been changed. Please see the details in the amended circuit diagrams included with the kit.

The Dial circuit has also been slightly modified. U18E (7407 inverter) is no longer used to drive the LED. A new transistor (Q5 – a 2N3904) has been added to the circuit for this purpose.

U19 (was a 74LS04) has been replaced by a 74HC14 Schmitt Trigger. Please note that all of the 74 series chips (with the exception of U16) should be "HC" series parts, *not* "LS" series parts. R5, R8, R29 and R30 (were 10k) have all been replaced with 47k and C45 and C46 (were 22 pF capacitors) have been replaced by 10 pF capacitors.

Resistor R18 has been changed from a 22k resistor to a 30k resistor. Note that this is *not* one of the preferred value types – however a 27k may be used as an alternative.

WARNING – XTL3 is a specially selected crystal (19.6608 MHz) – it has a tolerance of 20 ppm or better and an inferior component may *not* be substituted. It can be identified in the kit by the white mark on the back of the can.

A clip-on heatsink has been provided for U23. This is the analogue +5 volt regulator. The heat sink should be secured to the adjacent capacitor (C3) with a blob of silicone adhesive.

Testing procedures

As most constructors of previous Maestro projects will be aware, there is very little practical testing and diagnosis that can be performed on a circuit of this complexity, unless you have access to the appropriate test equipment (e.g: a high frequency CRO or a logic analyser).

For those readers who have reached this stage of the project and still haven't decided whether or not to construct the kit, it may be a good time to re-emphasise the fact that the modem is available in ready-built form for only $50 extra. Any potential constructor having second thoughts about his/her capacity to construct the project should seriously consider the built-up version. Constructors are also reminded of the "Sorry Maestro – it doesn't work" offer ($35) *and* the conditions attached thereto (published in the May issue).

Given all the above considerations, we shall now attempt to describe the process of determining the source of problems for an inoperative Superbis modem.

The first point to check is always the power supply. Check all of the power rails for the correct voltage (I won't make any smart comments about checking that the power is actually plugged into the mains, or that your meter is on the correct setting and range, will I?)

If there appears to be no output on any of these rails, then check the input. If the input is present, with no output, then the regulator is likely to be at fault or be short-circuited or overloaded. Check each of these points. If there is no input, the plug-pack may be at fault, or the two input diodes (D8 and D9) may have gone open circuit. If you have access to a CRO, check the supply rails for any ac component in the dc supply. If there is any ac present, immediately switch off the power and check the orientation of all your chips – one may have been put in back-to-front.

If the chips are all correctly oriented and there is ac on the line, then remove all the chips from the board **(after turning off the power and remembering normal CMOS precautions)** and re-insert them one at a time. Re-apply the power after inserting each chip and check again for the presence of ac. If any chip produces the ac signal, then it is faulty and needs to be replaced. If none of the chips produced the fault, then there is a possibility of a bridge – check all the tracks for a

bridge. Also check the orientation of all electrolytic (including tag tantalum) capacitors, as one of these (the one with smoke rising from it!) may have been connected with reverse polarity.

Now let's perform a quick check of the processor circuit. When we constructed the circuit, we did it in two stages – the power and processor circuit and then the modem circuit. Obviously, one would not have continued with construction of the modem circuit if the power/processor section did not work. With your multimeter set to a low (10 – 20 volt) dc range, measure pin 24 of the Super8. If this pin is in a "hung" condition (in the 1.8 to 2.9 volt range), or if it is zero volts, then it is a sure indication that the processor hasn't found any of the ROM set-up procedures.

Once again, switch the power off *immediately* (unless you have access to a Logic Analyser) and check the ROM and RAM sections and their associated components.

Now comes the problem. If none of the chips appear at fault, then the time has come for some long and painstaking circuit tracing.

Set the multimeter to the lowest ohms range and check the continuity of every address and data line, both to and from the processor and the ROM/RAM. Also check the data and address lines for track-to-track shorting. Check for short circuits and solder bridges, particularly on tracks and pads that are closely spaced. If you can't find any fault, then the "Sorry Maestro" offer is your only option.

The next step in the check-out procedure is to determine if the DSP section is operating correctly. Fire up your favourite comms package and set it up to either 1200 or 2400 bps full duplex, with no parity, 8 data bits and 1 stop bit. Initiate the "analogue local loop-back" test mode by entering the command **AT&T1** (followed by a carriage return) from the Hayes command line mode (in either 1200 or 2400 bps – full duplex).

In this mode, any characters typed on the keyboard will be sent to the modem and then returned to the computer for subsequent display on the screen. You must be in *full duplex* for this to occur correctly. This test determines that the DSP section of the board is at least recognising characters and responding to them correctly. If this works correctly type "+++" to re-enter command mode.

Change the comms parameters on your software to invoke 300 bps and type the **AT&T8** Hayes command. This is a complete self-test of all operating baud rates, which will progressively test and display the results of each test as it is completed. The display will provide information on the protocol being tested and the number of errors encountered in 100 passes through the test procedure. If any of the above procedures fail to operate as expected, then I'm afraid it's back to the multimeter and the painstaking circuit tracing.

If the board successfully passes all of the above tests, then there are several further tests to perform, prior to final commissioning. Change the comms software to 2400 bps and type in the Hayes command **ATC1M2,** followed by a carriage return. A white noise sound should be heard from the speaker. This indicates that the analogue transmit section of the DSP chip is operating correctly.

If you have access to a CRO, this signal should also be present on pin 46 of the 2402, signifying that the operational amplifier is amplifying both transmitted and received carriers. If the DSP chips do not respond correctly to any of the above tests, *do not* continue operation – check immediately for any solder bridges or lack of data, control and address bus continuity between the 2401 and the 2402. If you have a CRO, check pin 6 of the 2401 for a 4.9152 MHz clock. If the clock is not present, check the area of XTL3 for shorts or solder bridges.

The final test

The last test is to check out the Telecom portion of the circuit (see the boxed panel on Modems and Telecom, last issue). A 600 ohm resistor should be placed in series with the two points where the Telecom cable is to be connected.

With the modem turned on, the command **ATH1C1M2,** followed by a carriage return should be entered from the keyboard. At this point a carrier should be heard coming from the speaker. A multimeter (preferably analogue) graduated in dBM should be used across the resistor. The level obtained should not be greater than –10 dBM (0 is greater than –10 dBM). If the level is greater than –10 dBM, there is a fault with the hybrid amplifier circuit. The results of this test may fluctuate a bit, depending on the quality of the multimeter used, as some multimeters measure dB, as opposed to dBM. The top frequency range of the multimeter may also affect the results of this test.

The above procedure represents the limit of any tests that can be carried out without a complete diagnostic workshop. If, after all the above tests have been exhausted the board still does not operate correctly, please contact Maestro to obtain a "Return for Service Authorisation Number".

In the next article I will describe the operation of the software and the manner in which you can control the modem directly from the Hayes Command Line (over-riding the control of the comms package you may be using).

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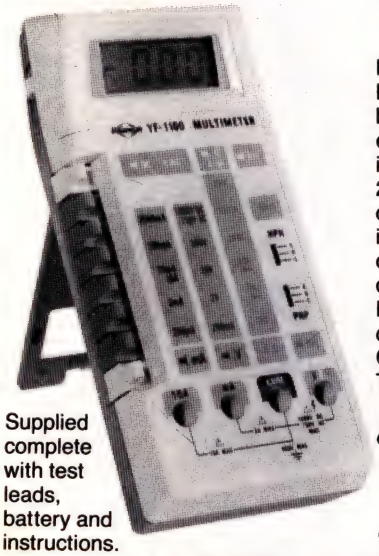

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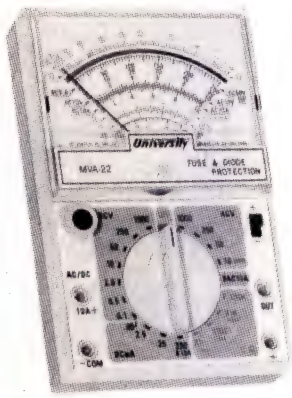

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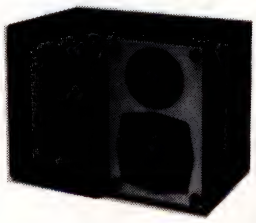

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Multimeter hazards

Safety in the workshop, lab or hobby room is a subject which should be of prime concern to all of us, but its all too easy to adopt the "it-couldn't-happen-to-me" attitude. Potentially lethal currents and voltages are present in the most innocuous-looking household appliances, and those of us who approach mains voltages, multimeter in hand, really should be aware of the hazards involved.

MULTIMETERS ARE NOT in themselves dangerous devices, but they are often used in close proximity to mains and other high voltage sources which have the capacity to kill or injure the unwary. Before we suggest ways of avoiding unfortunate incidents, an examination of the possible effects of human contact with high voltage is necessary.

Typical reactions to applied voltage and current

Individuals will react to identical voltage and current situations in any number of unique ways, so the reactions described must be regarded as *average* and *probable* reactions to the particular figures given.

Naturally, the state of a person's health (in particular their cardiac condition) will have a significant effect on their tolerance of high voltages. The figures are considered typical for adult males; the corresponding values for adult females are considered to be roughly 65% of those given for males.

Current rather than voltage is specified because the reaction to voltage varies widely from person to person. The impedance of a person's body, which fluctuates significantly with moisture and varying pressure of contact, is too unpredictable to allow for calculations in terms of voltage alone. Remember the old saying; *"Its the volts that jolt, but the mils that kill."*

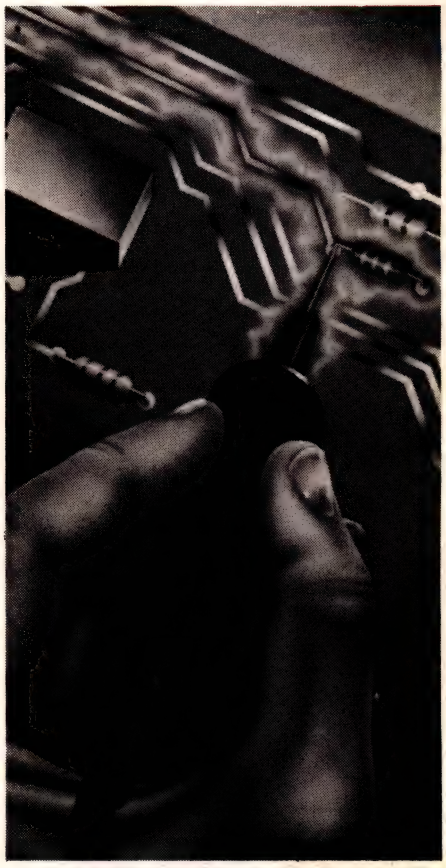
Dry skin has a resistance perhaps ten times (or more) greater than when wet. The same voltage that would be safe with dry skin may give the recipient a "surprise" reaction (see below) with wet skin. The area of the body where the voltage was applied can also vary the reaction.

Contact with voltages below 25 Vac or 60 Vdc is normally considered to be safe – bearing in mind the variability of individual responses.

PERCEPTION LEVEL

This is the level at which the operator will *just* sense the presence of current.

Levels as low as 1 mA current with a 1 second contact can be detected as a slight warmth in the palm of the hand when in contact with direct current, or, in the case of alternating current, a mild tingling sensation.



A multimeter probe with a finger guard, which helps prevent accidental contact with the circuit under test.

SURPRISE LEVEL

The reaction caused by this level of current is sudden, involuntary and totally without warning.

An unexpected reaction will result at this level, such as pulling one's hand away from the source of shock with enough force to cause an accident – or in confined spaces it may cause contact with other nearby exposed terminals. The reaction becomes more violent as current and voltage levels increase.

FREEZE LEVEL

As current increases the *freeze* level is reached, at which point the hand muscles contract to the point where the operator has no control.

Inability to let go would "freeze" the victim to the conductor long enough to cause lung or heart stoppage.

PROBABLE REACTION TO DIFFERENT LEVELS OF CURRENT

ac (50Hz) (mA)	dc (mA)	Effects
0-1	0-4	perception
1-4	4-15	surprise
4-21	15-80	reflex action (freezing starts)
21-40	80-160	muscular inhibition
40-100	160-300	respiratory block
over 100	over 300	fibrillation (usually fatal)

Recessed input jacks, such as shown on this Univolt meter from Benelec, also assist in preventing accidental contact.

Effects of electric shock

Electrical contact may cause burns in either of two ways. Firstly by touching a high voltage, high current supply, when the resulting arc produces sudden and tremendous heat resulting in a burn, or, secondly, by coming into contact with a high frequency current source, causing a burn under the skin.

Also, the heart can go into fibrillation if sufficient current is passed through it. Recovery from this is seldom spontaneous.

Another potential danger is presented by high-energy circuits, which can cause the equivalent of welding arcs when shorted, having the potential to flash-burn the eyes or cause injury from flying molten metal.

Multimeter hazards

The dividing line between *high* and *low* energy circuits is often given as 3600 volt- amps (240 V, 15 A). Above this figure, a poorly designed multimeter, or one designed for light duty, is more likely to break down, resulting in damage and possible operator injuries.

Meters being used under these conditions should incorporate high voltage fusing, ohms overload capability and transient protection.

The VOM4, in common with others in Arista's range of digital multimeters, features probes fitted with finger guards and shrouded plugs for maximum safety.

FAULT CONDITIONS occur when a circuit is accidentally shorted, or the multimeter itself is overloaded. Faults can cause *arcing, sparks, fire, explosions* or other immediate hazards. A simple overload of the multimeter is not a fault, as long as the meter has the built-in capability of withstanding the overload without damage.

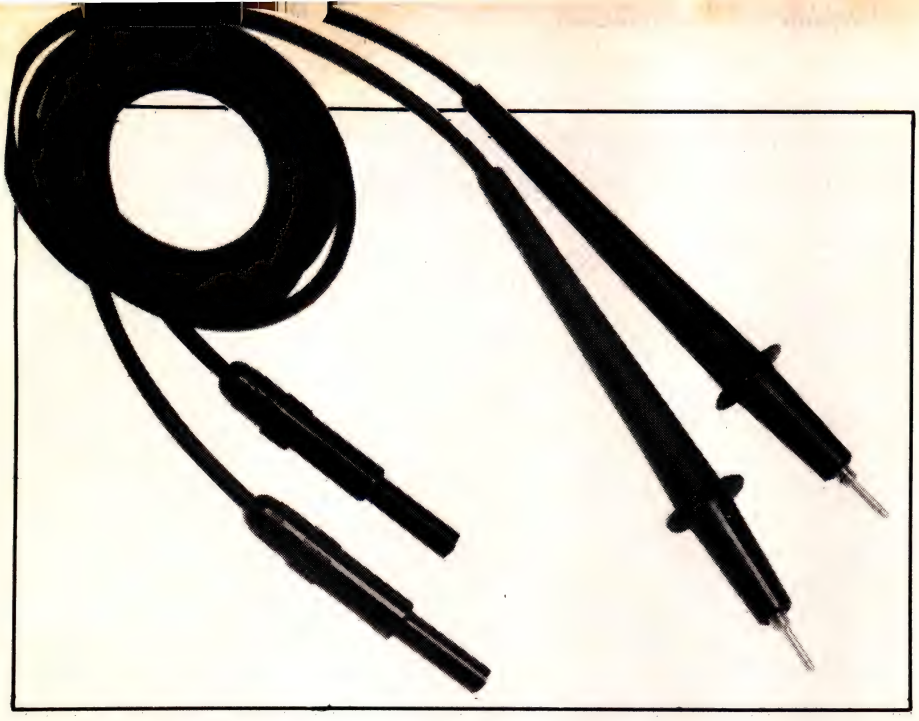
There are many situations which can lead to a fault in a circuit, varying widely depending on the design, location and application of the circuit in question. Common situations which may lead to faults include the following:

- Accidental contact with a high voltage power line while in the current mode.
- Accidental contact with power lines while in resistance mode.
- High voltage transients from motor switching, load change, or indirect lightning surges.

Better quality meters incorporate protection against the above situations. The result may be temporary incapacitation *of the meter* through blown fuse or fuseable resistor, but actual damage to the meter, or more importantly, to the operator is avoided. Lower quality meters can cause considerable and unpredictable damage when abused in this fashion.

UNSHELTERED LOCATIONS, including those which promote condensation, could directly lower the insulation value of the multimeter and its accessories. This could present a direct danger to the operator, or could cause errors in measurement which could lead indirectly to hazardous decisions by the user.

HAZARDOUS ENVIRONMENTS may be encountered when working in confined or poorly ventilated areas. Vapours from petrol or solvents, or the gases generated during battery charging, can contribute to a potentially explosive atmosphere. Only meters specifically designed and approved for hazardous locations should be used in such circumstances. Even simply disconnecting test leads from live circuits in such environments, especially while measuring current with inductive loads, may create a dangerous spark.



Elmeasco distribute the range of Coline multimeter accessories, which includes these 'safety' leads with shrouded plugs and probes with finger guards.

Prevention is better

As always prevention is better than the cure. Being aware of the unpleasant or dire effects of carelessness in multimeter usage is only the first step in avoiding injuries, (or worse). It is worth the time and effort to avoid mishaps. Its easy to be wise *after* the event, but here we are going to encourage a Solomon-like wisdom which will hopefully *avoid* any disastrous accidents.

When using a multimeter in potentially hazardous circuits, **ALWAYS:**

- Inspect the test leads for insulation damage or exposed metal. Damaged leads should be replaced **immediately.**
- Reduce the risk of accidental contact by using leads with shrouded connectors and finger guards. Meters which have recessed input jacks are also a good idea.
- Check the continuity of *each* test lead. This is best done by plugging ONE lead into the meter, selecting the resistance scale on the instrument, and shorting the probe to the other input jack. Do this for each lead, ensuring both are of similar resistance.
- Be sure the meter itself is in good condition. A continuity test, for example, should yield meter movement (or display) over the full range from zero to infinity.
- Select the proper function and range for your measurement *before* attempting to take a measurement.
- Electrically disconnect the "hot" end first. (Don't leave the meter leads live unnecessarily.)

The following are definitely recommended as **SAFE PRACTICES** to be followed at all times:

- Insulate yourself from earth ground, ideally with an insulating floor mat. If possible, keep one hand in your pocket or behind your back.
- Follow all traditional equipment safety procedures, disconnecting the power and discharging large value capacitors prior to testing.
- If working around a CRT consider wearing safety glasses in case of implosion of the tube.
- Avoid working alone, especially in isolated areas, if at all possible.
- Turn the power off before using a current shunt, to avoid overloading and heating the shunt.
- Use clamp-on probes if measuring currents greater than 2 amps.
- Be aware of the high voltages (typically around 30 kV) present in automotive ignition circuits.

Why bother?

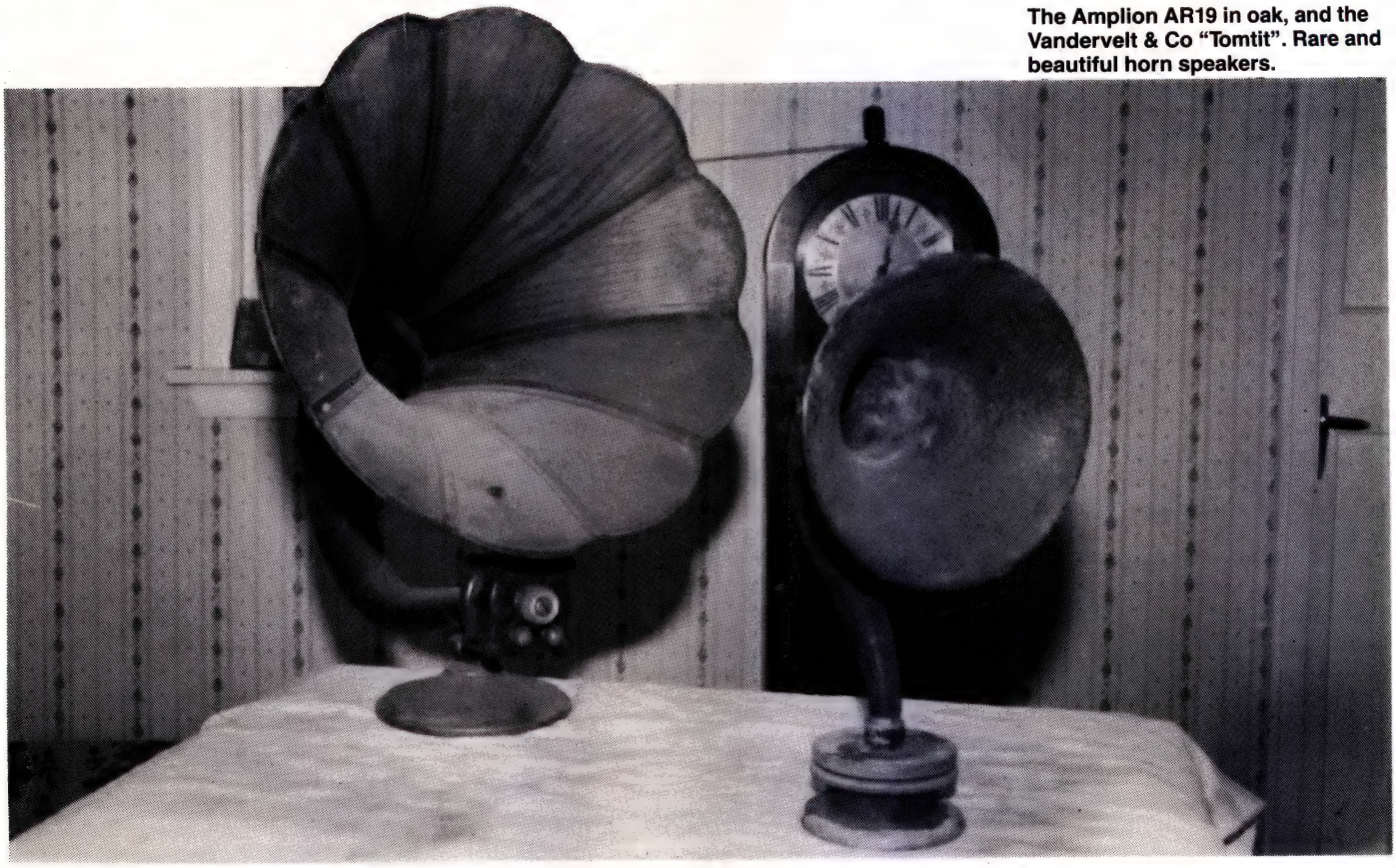
What a lot of "rules" to remember – just to use a multimeter! They prompt the inevitable question . . . "Why bother?" I am drawn to an anecdotal reply, concerning a neighbour of years past. He is (now) one of the most safety- conscious people I know, following an unfortunate incident a few years back. He was using an improperly guarded angle-grinder, and wearing minimal eye protection, when the cutting disk disintegrated, shattering his lower jaw in the process.

After a few months of eating nothing but soup, and contemplating his not-inconsiderably scarred face, he decided that foresight might have been more profitable than hindsight. The last time I saw him using an angle grinder he was dressed up in his welding outfit – leather coat and gloves and a full-face mask – like a veritable Ned Kelly. And the machine's guard was bolted firmly in place.

What does that have to do with gentle little multimeters? The principles are the same, the possible effects are just as horrendous, but the precautions are probably easier to implement than with power tools.

We don't like to lose readers by any means, and electrical accidents to present a definite risk to enthusiasts, tinkerers and tradesmen alike. This is one situation where nobody really wants to be given the opportunity to say "I told you so!"

Thanks to Elmeasco Instruments P/L, local distributors of *Fluke* digital multimeters, who provided the booklet "Multimeter Safety", on which this article was based. Elmeasco can be contacted at **PO Box 30, Concord 2137 NSW. (02)736 2888.**



The Amplion AR19 in oak, and the Vandervelt & Co "Tomtit". Rare and beautiful horn speakers.

Of horns and heterodynes

This issue we cover horn speakers and explain the technology employed in old radio receivers, an understanding of which is essential if you're to have any success in restoring them.

IN THE TEN YEARS from 1920 to 1930 the design of radios evolved tremendously. The development of increasingly better sound reproducers was very much part of this revolutionary change. The horn radio speaker was a development of the horn speaker used by nearly all wind-up gramophones of the earlier period, pre-radio.

The horn speaker was replaced around 1928 by the new- fangled "cone" speaker types – but by then thousands of horns had already been sold.

Early development

The first horns were like funnels pointing straight up, or with a right angle bend in them near the top. They used half of an ordinary pair of headphones mounted in the bottom of the funnel to produce the initial vibrations which were amplified by the shape of the funnel.

This is precisely the same theory behind the megaphones used by athletic coaches in sculling races in the early 1900s.

The horns themselves were made of anything from papier mache to plaster and cement. The most common materials were wood, steel and brass. As the years went by, manufacturers such as Amplion, Brown BTH, Magnavox and Atwater-Kent produced horns with improvements said to reduce ringing and resonance (a common complaint), increase volume and improve aesthetics. In fact, reading advertising material of the period would lead one to believe they produced *perfect* sound!

Far from this, unfortunately, horn speaker sound reproduction was usually abysmal, and the horns were rightly replaced by cone reproducers, which eventually led to the high quality speakers of today. However, most critics will still appreciate the beauty of horn speakers, and even in their primitiveness, their basic functionality!

Basic drivers you'll find include earphone types as mentioned, voice coil types (rare, more recent) and the driver arm type. These will be discussed in a later issue. Nearly all drivers have either 120 or 2000 Ohm windings.

Horn speakers today

Horn speakers are pretty thin on the ground nowadays. This may be due to one of the following three factors:

- Many of these large and fragile horns have been damaged or destroyed over the years;
- They were expensive to produce, consequently there were not vast numbers released onto the market;
- Recent US surveys suggest that collectors are hoarding the great majority of the limited number of horn-speaker-equipped radios.

Of eighty odd collectors surveyed, 1235 horns were discovered. That's about *fifteen* each! So, if you want to begin collecting, you will have to be prepared to start spending. There is no risk

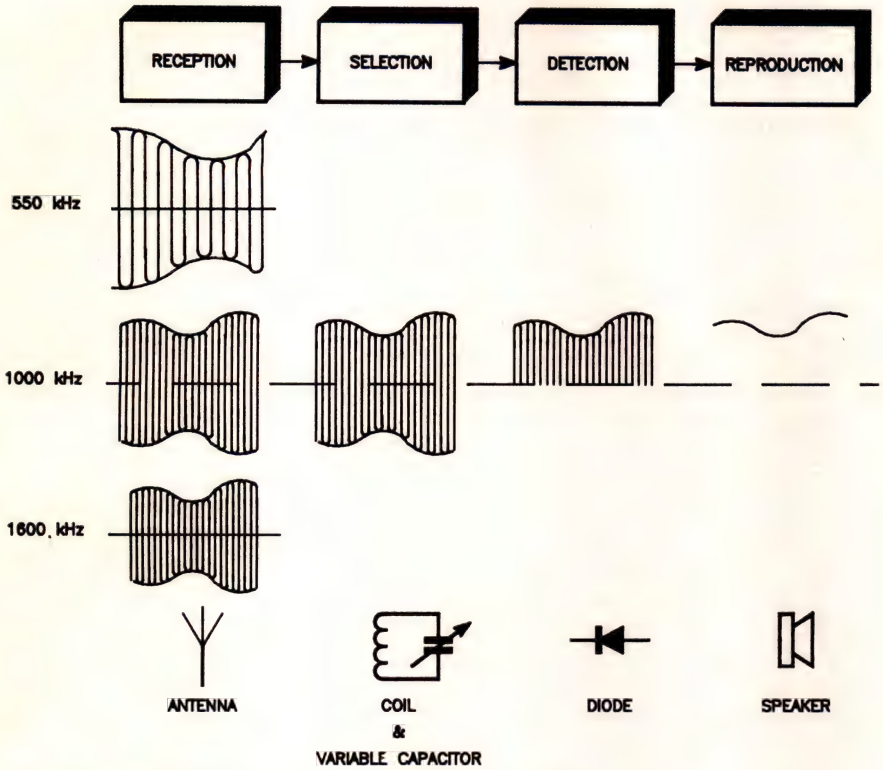


Figure 1. The four basic requirements of any AM receiver.

of losing money when investing in early horn speakers – should you find one. A strong market will always exist.

Later I'll be discussing the process of restoring horns.

Radio circuit technology

Vintage radio restoration, tricky as it may be with the scarcity of replacement components, is further complicated by the fact that a number of entirely different circuit techniques were commonly employed by the designers of the day. As a basis for interpreting and understanding older radio circuits as they are found, we present here a discussion of the two techniques that were widely employed.

Radio receivers of any vintage are necessarily designed as compromises of many conflicting factors. These factors were very well understood in the classic period of the twenties and thirties, and the techniques used to overcome the conflicts, and to produce reliable, predictable results are still in use in the most modern silicon-chip-filled receivers. Following is a discussion of the two pre-eminent techniques of the time, tuned-radio-frequency (TRF) and superheterodyne (or superhet).

Principle of AM reception

All AM receivers, regardless of the techniques employed in their design, must fulfil four basic requirements, as illustrated in Figure 1.

RECEPTION: When a radio wave cuts through a conductor, it induces a current in it. In a radio receiver, that conductor is called the *antenna*.(Or *aerial* – the aerial plus the lead-in wire comprise the antenna circuit.) The antenna forms in effect a capacitor, with the earth being the other "plate" and the air in between being the dielectric. The earth, as such, is not necessary, and can be replaced (in mobile installations, for example) by an artificial earth or ground, the *counterpoise*.

The function of the antenna is to pick up the voltage induced by the distant transmitting station, and conduct it to the next stage of the circuit.

SELECTION: The antenna conducts not only the desired signal, but also all the other unwanted stations, and types of interference. Some means must be employed to weaken all the unwanted signals, whilst still passing the wanted one. This is accomplished with variable resonant circuits, and is called *tuning*, or *selection*.

DETECTION: After selection, a single modulated carrier wave is available to the circuit. The purpose of the *detector* is to separate the signal wave (containing the programme *intelligence*) from the modulated carrier wave.

Figure 2a shows the waveform of the received signal as output by the tuner. The average output is zero. Following detection, in Figure 2b, one half of the wave has been removed, or *rectified*. The average current output is shown in Figure 2c, and this represents the waveform of the original audio signal produced at the studio.

Various mineral substances have been used as detectors in vintage crystal sets – carborundum, silicon, iron pyrites and the most popular, galena. Valve and semiconductor diodes performed the function later.

REPRODUCTION: We cannot hear a varying waveform travelling in a conductor – it must be converted to audible sound by the earphone or loudspeaker. In its simplest form, the varying rectified current output from the detector is applied to the windings of an electromagnet, which vibrates a metallic diaphragm, producing sound-waves.

These are the four basic requirements of all AM receivers, be they the simplest crystal set or the most sophisticated digitally synthesised, scanning, 100 channel megabuck monster. What distinguishes the types are the specifications they provide in the following areas.

Characteristics of AM receivers

To work at all, a receiver must fulfil all of the above requirements. *How well* it does so is gauged by how it performs in these categories.

SENSITIVITY: is that which determines the minimum strength of signal input capable of causing a desired value of signal output. In more practical terms, how well the receiver can "pull in" weak or distant stations.

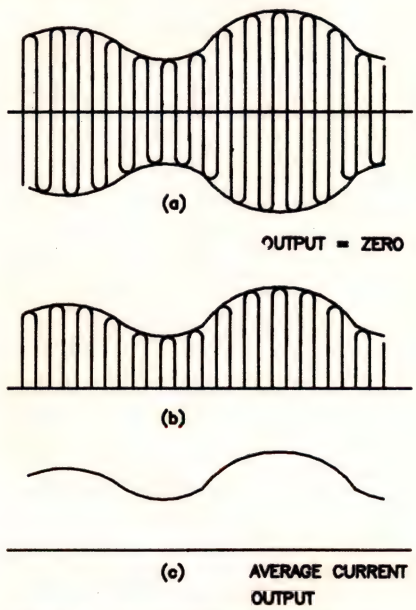


Figure 2. The process of detection of an AM radio signal.

SELECTIVITY: is that which determines the extent to which a receiver is capable of differentiating between the desired signal and disturbances of other frequencies. ▷

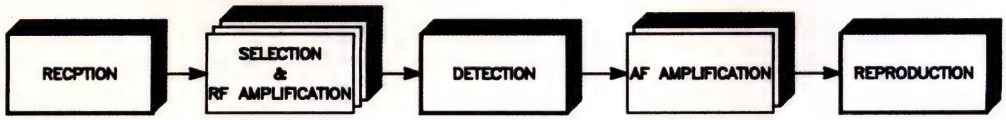


Figure 3. Block diagram of the basic Tuned-Radio-Frequency receiver.

FIDELITY: is the degree with which a system, or portion of a system, accurately reproduces at its output the essential characteristics of the signal which is impressed upon its input.

STABILITY: may be defined as a measure of the ability of a receiver to deliver a constant amount of output for a given period of time when supplied with a signal of constant strength and frequency. Instability can, in some circuits, lead to objectionable feedback howling.

SIGNAL-TO-NOISE RATIO: is the ratio of the *signal* power output to the *noise* power output at a specified value of modulated carrier voltage applied to the input. Alternatively, a measure of how well the receiver rejects internally generated noise, such as mains hum.

In addition to the above, principally technical, requirements we have the overwhelmingly important factors of *cost, complexity* and *availability* (of components). Obviously these considerations will be just as significant to a designer as the purely electronic and physical ones described above. The issue of *size* tends to have more significance nowadays than it did in the classic era, when designs where often, but not always, laid out with oodles of room to spare.

Any single design is bound to be a compromise of the above factors. Some techniques for receiver design tended to compromise some particular factors, whilst providing excellent results in other areas. In each category of receiver, there were and still are many varied styles and methods of implementation.

The two most popular techniques employed in the vintage era were the **TRF** and the **superhet,** the latter remaining the dominant modern choice.

Tuned-radio-frequency (TRF)

In a tuned radio-frequency amplifier system a number of tuned amplifier stages are adjusted, usually by a single dial, to the different frequencies of the stations to be received.

For normal operation on the broadcast band, therefore, the tuned circuits are designed so that they may be adjusted to tune to any frequency between about 540 kHz (555 metres) and 1600 kHz (188 metres).

The principle of operation of the TRF technique is shown in block form in Figure 3. The signal voltage is induced in the antenna circuit; is then amplified by the RF amplifier; is detected or rectified (changed to audio frequency); and is finally amplified further by one or two stages of audio amplification, the output from the audio amplifier driving the loudspeaker.

The second and fourth blocks in Figure 3 are shown "stepped" to indicate that multiple stages may be employed in those sections, each successively increasing the amplification. It is important to note that in the TRF amplifier system the signal is amplified *at its own carrier frequency.* This factor is responsible for one of the leading deficiencies of the TRF system – namely that it is difficult to design a receiver of this kind to give high amplification, good selectivity and high fidelity of reproduction.

It is difficult for valve circuits to obtain amplifications of more than 40 or 50 per stage, owing to the high frequency of the signal being amplified. This means that many successive stages must be used if high sensitivity is to be obtained. The RF amplification of each stage is *not* uniform over the entire broadcast band unless special circuit arrangements for constant coupling are employed. This introduces excessive expense and complexity to the circuit.

Also, band pass tuning circuits must be employed. Since these circuits must be of the variable tunable type, tunable to any frequency in the broadcast band, they could not be built with as great efficiency as they would have if designed to work at one single frequency.

The successive resonant circuits in the RF amplification sections were usually tuned by means of coupled variable capacitors, in which a number of independent variable capacitors were ganged on a common axis, and connected so that they turned together. By this means all the resonant circuits were tuned to the same frequency when the tuning dial was adjusted.

The superheterodyne receiver

Instead of selecting and amplifying the signal at its own particular carrier frequency, the superhet receiver changes that high carrier frequency to a lower fixed frequency, so it can be amplified and selected much more efficiently.

Heterodyne reception (beat reception) is the process of altering the radio frequency of a signal to obtain similarly modulated waves of different frequencies – in general the process includes the use of a locally generated frequency.

Superheterodyne reception is a form of heterodyne reception in which one or more frequency changes take place before detection. In practice, only one change of frequency is effected in broadcast-band AM receivers. More may be employed in higher frequency (shortwave) receivers.

The fixed lower frequency at which the signals are amplified is called the *intermediate frequency,* or IF.

The principle of operation of a superhet receiver is shown in block form in Figure 4. The signal voltage is induced in the antenna circuit, then amplified and partially selected by the RF amplifier. At the mixer (and first detector) the signal is mixed with the output from the local oscillator, which produces a *beat frequency* output at the lower intermediate frequency.

The IF amplifier both amplifies and further selects this signal. Detection and AF amplification proceed in a similar fashion to the TRF.

TRF vs superhet

The superhet tuner possesses advantages which the TRF technique could never achieve.

The amplifying is done (except for the first stage of RF amplification) at the comparatively low fixed-frequency to which the IF amplifier is tuned. (This is commonly 455 kHz in modern sets, often 175 kHz in older sets, although

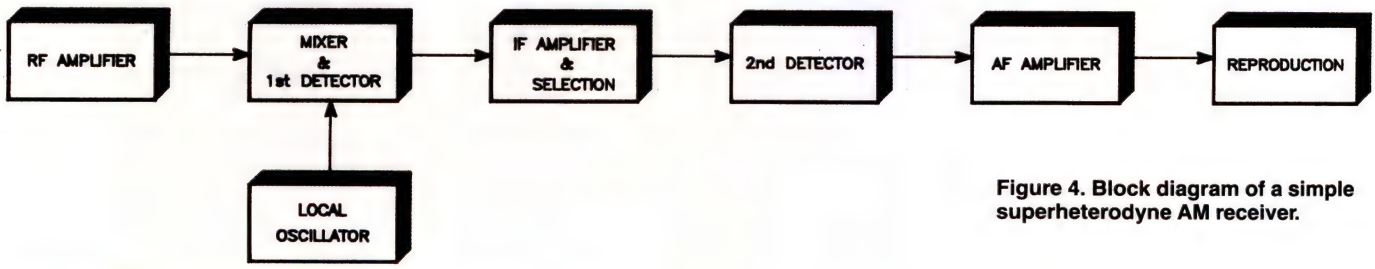


Figure 4. Block diagram of a simple superheterodyne AM receiver.

many other values were chosen to suit specific design and location difficulties.) Each successive valve amplifier stage can operate up to twice as efficiently at these frequencies than at broadcast-band frequencies.

It should be noted that TRF receivers can be built to be just as *sensitive* as superhets, by adding further amplifier stages. The point is that in the superhet system the same sensitivity can be produced with *fewer* amplifier stages.

Since the IF amplifier stages operate at one fixed frequency, it's possible to use band-pass tuning of a form designed to have much more nearly the ideal straight-sided, flat-topped tuning characteristic needed for good selectivity performance.

Another aid to selectivity in the superhet is the so- called *arithmetical selectivity* which is obtained. If, for example, an unwanted station is 10 kHz away from the desired signal at 1000 kHz, then it is only 1% removed, requiring sharp cut-off of the selector filtering. When heterodyned to the IF at roughly half that frequency, the offending station is still 10 kHz away, but that now represents 2% of the signal – considerably easier to filter out. This advantage was much more apparent when a lower IF (e.g. 175 kHz) was employed.

Therefore, in a superhet it is relatively easier to obtain the high selectivity required for congested band conditions.

The problem of avoiding the *image frequency effect* was probably the most serious drawback in the development of the superhet system. This is caused by the fact that, for any particular local oscillator frequency, there are two frequencies which will produce the IF, one below and one above the local oscillator. Only one of these is wanted, so the other must be filtered out in the RF tuning or preselection stages. This effect, while present in broadcast-band receivers, is more of a problem in shortwave receivers.

And the winner is...

No doubt inertia was responsible for some of TRF's latter popularity – that is, the unwillingness to change designs which seemed perfectly satisfactory at the time. The extra steps in the superhet design may have represented a leap in complexity which unnerved some of the designers and manufacturers of the day. The inherent simplicity of TRF, where extra sensitivity or speaker volume was obtained by simply adding further similar (or identical) stages, must have appealed to the rationalists.

The efficient use of scarce and expensive components, however, guaranteed the eventual success of the superhet. Increasingly congested broadcast bands dictated improvements in selectivity which the superhet best provided.

Clearly, the superhet is the superior technique, as shown by its predominance today. TRF lingers on as an alternative system, however, and any person considering sympathetic restoration of a vintage radio must have a clear conception of its fundamentals.

Handy hints

Every month, we'll endeavour to provide a few handy hints to help restoration enthusiasts with the common problems encountered.

Screws, knobs and shafts "frozen" in place by corrosion can be the devil to shift. What you need is a liquid that can penetrate the corrosion and loosen or dissolve it. While WD40 is widely used, an even better product, known as *Penetrene*, is recommended. It can be obtained at hardware stores and motor spares retailers. It is best used sparingly, a few drops in strategic positions around the offending object will do. Leave it for a few minutes – or longer – to do its work, then gently try shifting the part, using a rocking or reciprocal motion. In really bad cases, leave overnight. Take care with this liquid, it can seriously stain dials, etc. So take care not to drip it anywhere.

High voltage capacitors, suitable for replacing dud or suspect parts in a receiver, can be obtained from several sources. For Victorian enthusiasts, a variety of electrolytics and polyester capacitors can be obtained from **All Electronic Components** at 118 Lonsdale St, Melbourne, phone (03)662 1381. In NSW, **Pre-Pak Electronics,** has a selection of high voltage plastic, ceramic and electrolytic capacitors. They have two stores, at 1A West St, Lewisham – phone (02)569 9797 – and at Cowper St, Granville, phone (02)637 1221; both are near the local railway station.

CCDs
• from page 90.

itself is well understood, but certain limitations n transfer efficiency and noise generation still need investigation.

The areas of input and output circuits can be improved with a view to faster signal transfer with high clocking speeds and lower noise levels.

Advances in CCD application and construction have been accelerated by the already available processing techniques used with silicon semiconductors.

The CCD has had its most significant impact in the area of compact low-powered image sensors. Linear and focal-plane arrays have found widespread use in industrial and domestic applications. With further development their use in the broadcast and military fields will also increase. To achieve this, higher resolution and increased sensitivity will be required. The problem of blooming will also need to be more thoroughly dealt with.

Signal processing is an important use of CCDs. The ability to construct highly accurate and variable analogue time delays without the need for A/D and D/A converters has many applications in filter design for sonar, radar and communications systems. The use of split electrode transversal filters is also an important application.

The use of CCDs in signal processing is limited by clocking rates, noise sources at the input/output interfaces and by the generation of dark currents in the potential wells.

Originally intended for digital and memory applications, the serial nature of CCDs makes them unable to compete with the versatility of semiconductor RAMs. Their future is assured, however, as imaging devices for the latest and next generations of video cameras, if nothing else.

Further reading

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Print buffer multiple copies

My print buffer, described in AEM March '87 (256k version 3.2 revision E), has proved to be very useful. However, the COPY function needs operator attention if multiple copies are to be printed. This can prove to be cumbersome for large numbers, and has led to the development of this add-on circuit which will count and control the number of copies from the printer.

BEFORE MODIFICATION

Data is sent from the computer to the printer via the Print Buffer, and it remains in the Buffer memory after the printer is finished until the Print Buffer is reset or it is written over.

If the COPY switch is turned on, then the file will be reprinted continuously until the COPY switch is turned off, at which point the current copy is allowed to finish. Therefore, for multiple copies it is necessary for the operator to count copies and turn the COPY switch off accordingly.

AFTER MODIFICATION

Single copy: When a normal printing request is made by the computer a single copy is printed as usual.

Extra copies: After a single copy is printed, the desired number of additional copies is set on the BCD switches, and the COPY switch is pressed to initiate the printing. The display (if fitted) counts down from the requested number of copies to zero for the final copy.

CIRCUIT DESCRIPTION

The COPY switch is disconnected from the original position at pin 10 of the 8255. The new COPY switch is a momentary-action type, connected to pin 11 (the LOAD pin) of IC2 and IC3 (presettable up/down BCD counters) of the Copy Counter circuit.

The output of the Copy Counter circuit is connected to pin 10 of the 8255. All other Copy Counter connections simply attach to the existing power and signal lines of the Print Buffer. The power connections are to 0 volts and +5 V, while the signal connections are to RESET and BUSY.

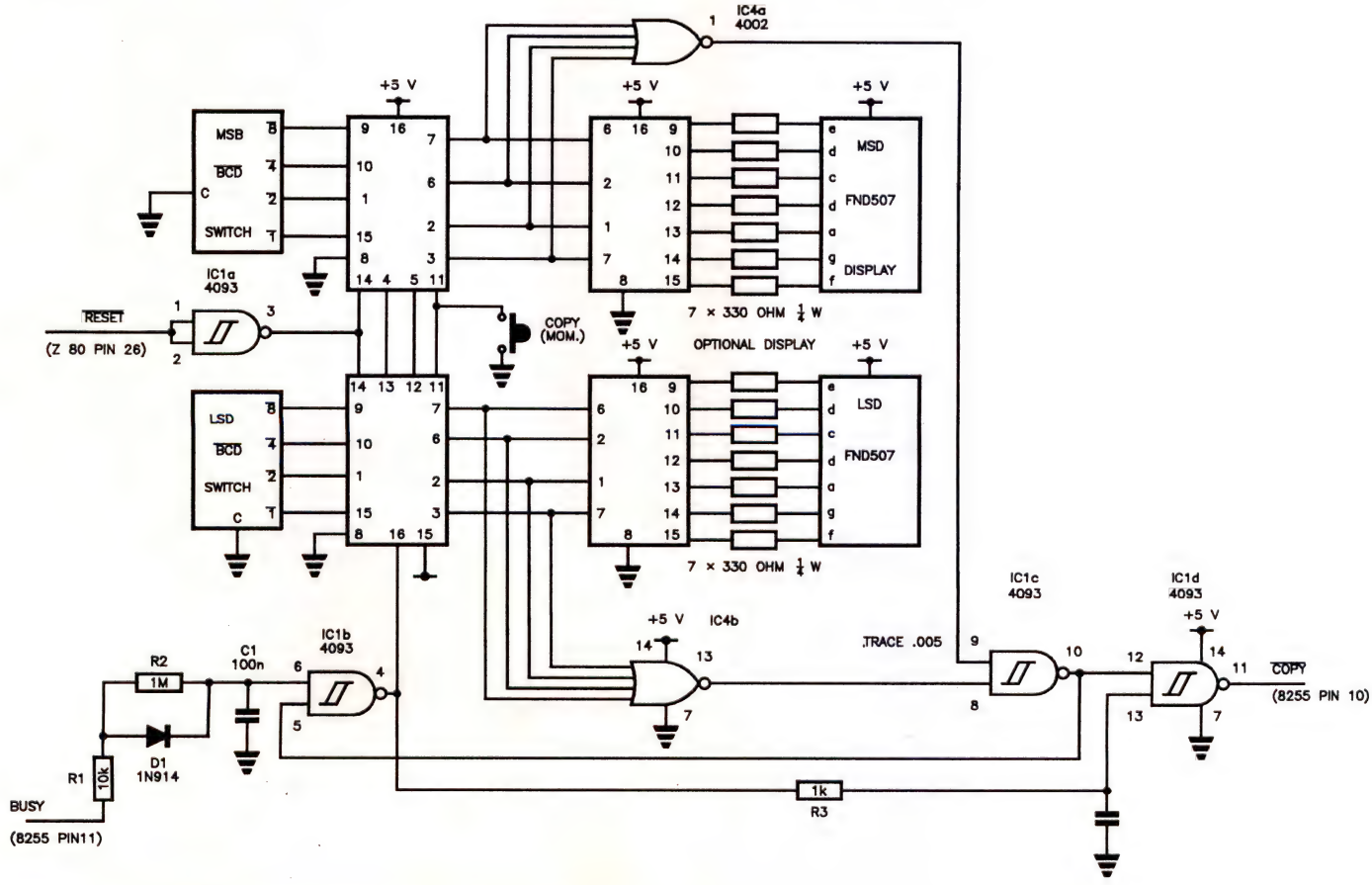
The desired number of copies (0-99) is set on the BCD (complementary) switches, and when the COPY switch is pressed the cascaded counters IC2 and IC3 are preset from the BCD switches. If IC2 and IC3 are loaded with "00", the outputs of IC4a and IC4b will both be HIGH and the output of IC1c will be LOW. This will disable IC1b and IC1d. If IC2 and IC3 are loaded with anything other than "00", then IC1c output will be HIGH, therefore enabling IC1b and IC1d.

When the printer is not busy, the signal at the 8255 pin 11 goes LOW, C1 discharges via R1 and R2, and after approximately 100 ms IC1b output will go HIGH. This is connected to the "down count" input of IC2 and IC3 and also pin 13 of IC1 via the delay circuit formed by R3 and C2. IC1 pin 12 is HIGH, therefore IC1d output goes LOW, which requests a copy via the 8255 pin 10. Each time the printer is not busy and the counters are not at "00" count, then another copy will be requested. This will continue until IC2 and IC3 reach the count "00".

The R-C circuit of R3 and C2 provide a short delay to allow for the propagation delays of IC2, IC3, IC4 and IC1c so that a "00" count will disable IC1d before a new copy is requested.

IC5, IC6 and the two seven-segment displays are optional. These show the state of the counters, and in operation they display the remaining number of copies to be printed.

IC1a is connected to the RESET line of the Print Buffer, which resets the coun-



ters IC2 and IC3 on power-up and when the reset switch is pressed.

POWER CONSUMPTION

Without the display option, the Copy Counter can be run directly from the existing +5 volts supply on the Print Buffer. However, if the displays are fitted another +5 volts supply will be needed. The extra current for the displays and drivers will be in the order of 200 mA with all segments lit.

Mark Gilbert,
Castle Hill, NSW

Speed control for dc motors

Here's a handy motor speed control circuit that's usable with a variety of dc motors, provides smooth control and works very reliably.

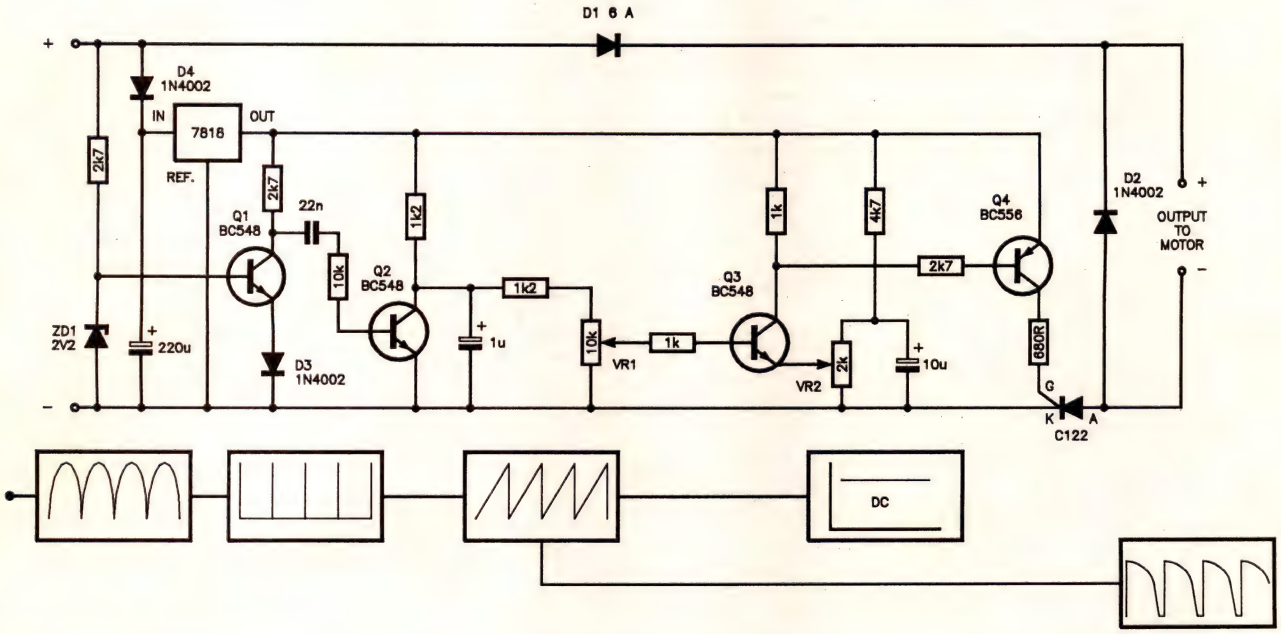
The circuit is best explained by referring to the waveforms in the "block diagram" below the circuit diagram. 100 Hz "dirty dc" from the power supply is converted to a sawtooth waveform and is compared to the dc level of VR2. This provides the phasing signal for the SCR.

D2 is a commutating diode. I was pleased to discover this in a reference book, and it is most important to control the motor at low speeds.

D1 prevents the back emf of the motor from lifting the zero level of the input timing circuit.

There are two ways of controlling the circuit: via VR1, the 10k pot, as a phase control; or via VR2, the 2k pot, by extending the voltage level of the comparator. This way, the 10 uF capacitor would provide ramp up/down or slow start/stop of the motor.

John Hewson VK7JX
Lindisfarne, Tas.



MISSING SOFTWARE, Electronic Joystick for the Microbee. June, p.96.
Our apologies, the listing was left out of this item in Benchbook in last month's issue.

```
ØØ1ØØ REM ### Microbee Joystick Test Program ###
ØØ11Ø POKE 22Ø,2Ø:COLOURB 8:COLOUR 15:CLS:LORES:
PLOT Ø,Ø TO Ø,47 TO 127,47 TO 12
7,Ø TO Ø,Ø:PLOT 1,1 TO 1,46:PLOT 126,1 TO 126,46
ØØ12Ø CURS 18,6:COLOUR 14:PRINT "Microbee Joystick Test Program"
ØØ13Ø CURS 8,1Ø:COLOUR 3:PRINT "Joystick position : ":COLOUR 9
ØØ14Ø OUT 1,255:OUT 1,255:A=Ø:CURS 28,1Ø:GOTO 24Ø
ØØ15Ø REM ### if fire2 is used, change 143 to 2Ø7 ###
ØØ16Ø A=IN(Ø):A=143-(A AND 143):IF A=D THEN GOTO 16Ø
ØØ17Ø CURS28,1Ø:PRINT [A3Ø 32];:CURS 28,1Ø
ØØ18Ø B=-(A AND 1):IF B THEN PRINT "up ";
ØØ19Ø B=-(A AND 2):IF B THEN PRINT "down ";
ØØ2ØØ B=-(A AND 4):IF B THEN PRINT "left ";
ØØ21Ø B=-(A AND 8):IF B THEN PRINT "right ";
ØØ22Ø B=-(A AND 64):IF B THEN PRINT "fire2 ";
ØØ23Ø B=-(A AND 128):IF B THEN PRINT "fire ";
ØØ24Ø IF A=Ø THEN PRINT "nothing ";A ELSE PRINT A
ØØ25Ø D=A:GOTO 16Ø
```

• from page 59

bead of glue along the joining faces first. "Tack" them in place, taking care to line them up, then screw them down. If the box is to be painted, rather than covered. Paint all the panels now.

Assemble the speakers to the front panel next. Take care here, lest you slip and pierce a cone with the screwdriver! Mount all the speakers with their connection tags facing the bottom of the cabinet, with the exception of the bottom speaker, which is mounted the other way up. This makes connection to it considerably easier. You can apply some sealing compound around the rim of each speaker before mounting, if you wish, although the integral sealing rings seemed adequate on our prototype.

With the drivers in place, screw the front panel in position, applying glue to the meeting faces first. Now apply a bead of glue around every internal corner of the box, to effectively seal it.

Now you can wire up the drivers as per the wiring diagram here. Take it carefully, one link at a time, and you'll avoid making errors. Check your work as you go. Note that the "+" terminal of each driver is marked with a red stripe beside it. If you're using a line transformer, screw it to the bottom of the box and wire it up as required.

Check out

With the drivers wired, check with an ohmmeter that they measure around two Ohms (without the transformer connected). Sort out any wiring errors now. Temporarily put the rear panel and bottom plate in place and connect-up a sound source. We put the prototype on a swivel chair and turned it around while playing speech and music through it, to get an idea of the sound radiation pattern. You can try it, too. Try it standing vertically (normal position) and then horizontally. The "fan" radiation pattern is readily discernable even standing just a few metres away.

Once you're satisfied all's well, complete the construction. Apply a silicone sealing compound around the meeting faces of the rear panel and bottom plate. This permits easy removal later, if necessary.

AEM2520

• from page 63.

As stated earlier, the AEM2520 can run off next to anything, except straight mains. Because it has no internal transformer of its own, it has to be connected to some source of voltage. Any transformer with less than 35 Vac output is suitable. Note that many transformers deliver slightly more than their "rated" voltage, so it may not be safe to use a "35 volt" transformer.

We recommend a value of about 32 volts. This means that you can use a cheap and commonly available '6672-type' (nominal 30 Vac at 1 A), the sort of transformer that is meant to run doorbells, or the type for pool lights and pumps, equally safely. Because of the low current consumption, dry batteries or sealed rechargeable batteries are also suitable. We recommend the latter if you want a *totally safe* variable power supply entirely divorced from the mains.

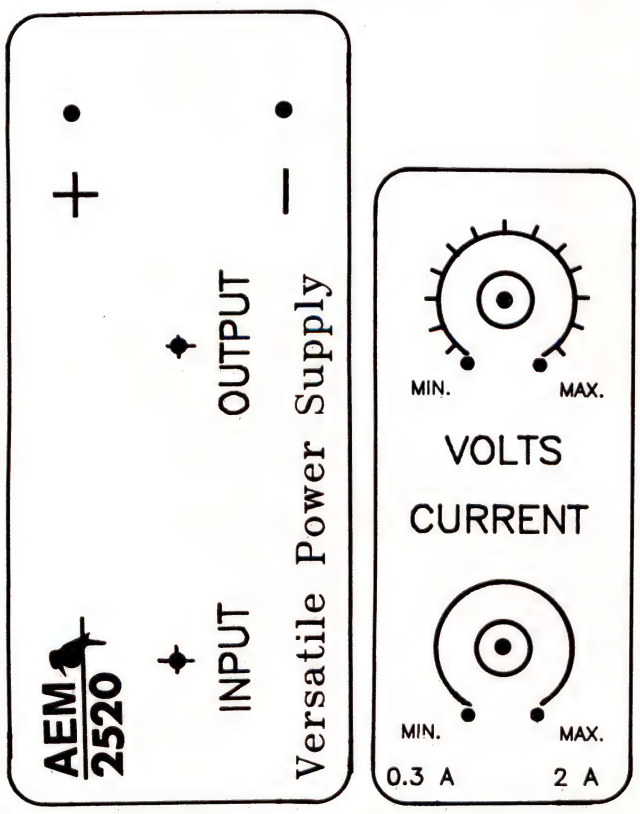
If you have occasion to need a power supply when you are "out in the field," a car battery (or two or three, or even four) can be hooked up and used as the input source.

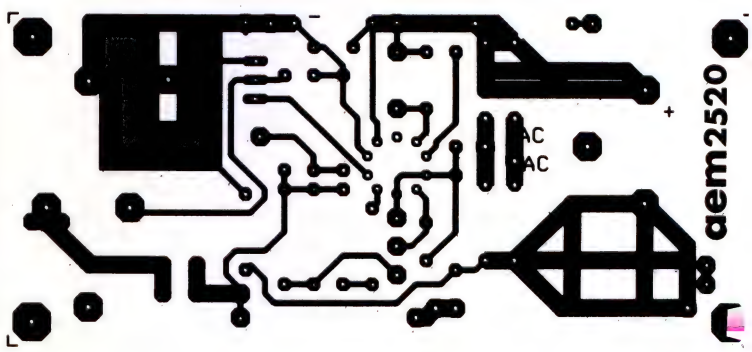
Because the regulation is very good, you can set the output voltage exactly with a multimeter with no load connected, and expect it to remain pretty constant if you do not alter RV1. We have made the panel with voltage markings around the voltage setting control, so that unless you want very exact control, you can simply work off the scale.

If you wish to set the limit current precisely, just set your meter to current range, and then connect it straight across the output terminals, and adjust the limit control and the range switch to get the level you want. The limit current will not stay *precisely* where you put it under varying load, but it will be constant to within a few percent.

If you run the supply into a short circuit with the limit set towards the maximum, the heatsink will soon get too hot to touch. If built properly, the supply should not be harmed, but you might be if you get your pinkies near the heatsink!

If you use the supply with fairy long leads (say, over one metre) attached between the output terminals and your 'breadboard' circuit, you are advised to put another small capacitor, such as a tantalum, at the end of the leads. This is because C5 cannot bypass the supply at your breadboard.





If you like discount prices... try Rod Irving Electronics!

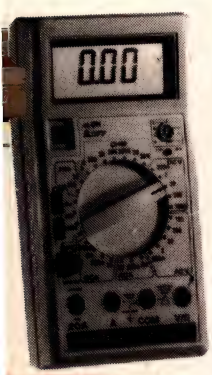
RS232 GENDER CHANGERS

- Saves modifying or replacing non-mating RS232 cables.
- All 25 pins wired straight through

Cat. X15650 **Male to Male**
Cat. X15651 **Male to Female**
Cat. X15652 **Female to Female**
Normally $14.95 each
Only $9.95

ELECTRIC FENCE CONTROLLER KIT

Restore discipline to the farm or allotment with this new electric fence controller. It features higher output power and lower current drain than the previous design for use in rural areas.
(EA Dec.'85. 85ef11)
Cat.K85110 ..... Normally $49.95
SPECIAL, $45.95



METEX M-3650 MULTIMETER

20A, 3½ digit frequency counter multimeter with capacitance meter and transistor tester.

This spectacular, rugged and compact DMM has a bright yellow high impact plastic case. It features a frequency counter (to 200kHz), diode and transistor test, continuity (with buzzer), capacitance meter, up to 20 amp current measurement and comprehensive AC/DC voltage, current and resistance ranges.

CHECK THESE FEATURES....

- Push-button ON/OFF switch.
- Audible continuity test
- Single function, 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- Transistor test
- Diode test
- Quality probes
- ½" High contrast LCD
- Full overload protection
- 20 Amp
- Built in tilting bail
- Capacitance meter
- Instruction manual

Q91550 .... Normally $165
Special, only $129

DB25 CONNECTOR SPECIALS!

TYPE	1-9	10+	100+
9P	$0.70	$0.60	$0.50
9S	$0.70	$0.60	$0.50
9C	$0.60	$0.50	$0.40
15P	$0.70	$0.65	$0.60
15S	$0.70	$0.65	$0.60
15C	$0.70	$0.60	$0.50
25P	$0.70	$0.60	$0.50
25S	$0.75	$0.65	$0.60
25C	$0.70	$0.60	$0.50

DB 25 CRIMP SPECIALS!

Type	1-9	10+	100+
Female	$2.95	$2.50	$1.95
Male....	$2.95	$2.50	$1.95

METEX 3530 MULTIMETER

This instrument is a compact, rugged, battery operated, hand held 3½ digit multimeter for measuring DC and AC voltage, DC and AC current, Resistance and Diode, Capacitance, Transistor hFE and Continuity Test. The Dual-slope A-D Converter uses C-MOS technology for auto-zeroing, polarity selection and over-range indication. Full overload is provided. It is an ideal instrument for use in the field, laboratory, workshop, hobby and home applications.

Features...

- Push-button ON/OFF power switch.
- Single 30 position easy to use rotary switch for FUNCTION and RANGE selection.
- ½" high contrast LCD.
- Automatic over-range indication with the "1" displayed.
- Automatic polarity indication on DC ranges.
- All ranges fully protected plus Automatic "ZERO" of all ranges without short circuit except 200 ohm Range which shows "000 or 001"
- High Surge Voltage protection 1.5 KV-3 KV.
- Capacitance measurements to 1pF
- Diode testing with 1 mA fixed current.
- Audible Continuity Test.
- Transistor hFE Test.

SPECIFICATIONS

Maximum Display: 1999 counts 3½ digit type with automatic polarity indication.
Indication Method: LCD display.
Measuring Method: Dual-slope in A-D converter system.
Over-range Indication: "1" Figure only in the display.
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 ..... **Normally $139**
SPECIAL $109

NICADS!

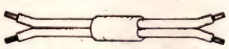
Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

Size	Desc.	1-9	10+	100+
AA	450 mA.H.	$2.95	$2.75	$2.50
C	1.2 A.H.	$9.95	$9.50	$8.95
D	1.2 A.H.	$9.95	$9.50	$8.95

POCKET SIZE BATTERY TESTER

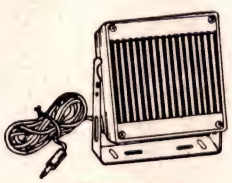
- Tests all 9V to 1·5V batteries including button cells.
- Arms extend to various battery sizes
- Easy to read meter.
- Requires no power source.

M23521 ..... **$11.95**



CAR BATTERY ISOLATOR

Designed for car burglar alarm back-up battery. Allows the back-up battery to be charged from the car battery and isolates the back-up battery by not allowing the back-up battery to drain back to the car battery.
A12095 ..... **$3.20**



CB SPEAKER

- 10cm (4") speaker
- 3 metre cord with 3·5mm plug
- Impedance 8 ohms
- Power 5 watts
- Complete with mounting bracket

Cat.A12074 ..... **$24.95**

MINIATURE HOBBY VICE

- Lever operated suction grip base for instant mounting and portability
- Mounts on smooth non-porous surfaces.
- Ideal for holding components, and other small/light objects.

Cat.T12458 ... **only $5.45**

QUALITY 3mm LEDS

Cat. No.	Col.	1-9	10+	100+
Z10140	Red	$0.15	$0.12	$0.10
Z10141	Grn	$0.20	$0.15	$0.12
Z10143	Ylw	$0.20	$0.15	$0.12
Z10145	Ora	$0.20	$0.15	$0.12

QUALITY 5mm LEDS

Cat. No.	Col.	1-9	10+	100+
Z10150	Red	$0.08	$0.07	$0.06
Z10151	Grn	$0.15	$0.12	$0.10
Z10152	Ylw	$0.15	$0.12	$0.10

KEY SWITCHES

	1-9	10+
Cat. S12500	Normally $7.95	
1-9	10+	25+
$4.95ea	**$4.25ea**	**$3.95ea**

MERCURY SWITCH

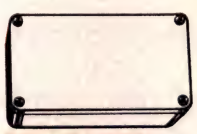
Cat.No.	1-9	10+
S13070	**$1.95**	**$1.85**

RECHARGEABLE 12V 1·2AH GELL BATTERY

Leakproof, long service life batteries ideal for security systems, emergency lighting or as a computer backup power supply, etc.

Cat. S15029 ..... **Normally $19.95**

1-9	10+
$13.95	**$12.95**



DIECAST BOXES

Diecast boxes are excellent for RF shielding, and strength. Screws are provided with each box.

H11451	100 x 50 x 25mm	$ 5.95
H11452	110 x 60 x 30mm	$ 6.50
H11453	120 x 65 x 40mm	$ 6.95
H11461	120 x 94 x 53mm	$11.50
H11462	188 x 120 x 78mm	$13.50
H11464	188 x 188 x 64mm	$29.50

RCA GOLD PLATED PLUGS AND SOCKETS

For those who need the ultimate in connection. Essential for laser disc players to get that fantastic sound quality.

Plug Cat. P10151	$2.95
Socket Cat. P10150	$2.25

CENTRONICS SOLDER PLUGS SPECIALS!

1-9	10+	100+
$2.95	$2.50	$1.95

QUALITY 3mm LEDS

Cat. No.	Col.	1-9	10+	100+
Z10140	Red	$0.15	$0.12	$0.10
Z10141	Grn	$0.20	$0.15	$0.12
Z10143	Ylw	$0.20	$0.15	$0.12
Z10145	Ora	$0.20	$0.15	$0.12

QUALITY 5mm LEDS

Cat. No.	Col.	1-9	10+	100+
Z10150	Red	$0.08	$0.07	$0.06
Z10151	Grn	$0.15	$0.12	$0.10
Z10152	Ylw	$0.15	$0.12	$0.10

WELLER WTCPN SOLDERING STATION

The WTCPN Features:

- Power Unit 240 V AC
- Temperature controlled iron, 24 V AC
- Flexible silicon lead for ease of use
- Can be left on without fear of damaged tips!

The best is always worth having.
Cat. T12500 ..... **R.R.P. $149**
SPECIAL, ONLY $129

30 V/1 A FULLY PROTECTED POWER SUPPLY

The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0V to 30V and selectable current limit. Both volatage and current metering is provided. (ETI Dec.'83) ETI 162

Cat. K41620 ..... Normally $73.50
SPECIAL, $63.50

9 PIN TO 25 PIN CONNECTOR ADAPTORS

NEW! The ideal solution! Features gold plated pins.

X15668: DB9 Plug to DB25 Socket
X15669: DB9 Socket to DB25 Plug
..... **each $10.95**

UTILITY BOXES

Plastic boxes with aluminium tops, and available in four sizes. Very popular for projects and very economical!

H10101	150x90x50mm	$ 3.25
H10102	195x113x60mm	$ 4.50
H10103	130x68x41mm	$ 2.75
H10105	83x54x28mm	$ 1.95
H10110	120x65x38mm	$ 2.95
H10112	120x65x38mm (Metal top)	$ 2.95

TELEPHONE ADAPTOR

- Australian plug to U.S. socket
- Length 10cm

Cat. Y16026 ..... **$6.95**

CANNON TYPE CONNECTORS

1-9	10+
P10960 3 PIN LINE MALE.	
$3.90	**$3.50**
P10962 3 PIN CHASIS MALE	
$3.00	**$2.50**
P10964 3 PIN LINE FEMALE	
$4.50	**$3.90**
P10966 3 PIN CHASIS FEMALE	
$4.95	**$3.95**

STEREO WIRELESS TRANSMITTER

This unit was developed to allow portable compact disc players to be used in cars by transmitting the headphone output signal directly in to your stereo FM car radio. It will also transmit any mono/stereo signal from any headphone output to any FM receiver.

SPECIFICATIONS:

- Input 3·5mm stereo phone plug. Impedance 32 ohm.
- Mono/stereo switch has plug mounting clip.
- FM Transmission approx. 90-35MHz (Tuneable 89-91MHz)
- Range 15 metres. (below 15mV/m at 100 metres)
- Power 1·5V AAA size batteries (100 hours continuous use)
- Size 72 x 38 x 21mm

A16100 ..... **$69.95**

Rod Irving Electronics

MELBOURNE: 48 A'Beckett St.
Phone (03) 663 6151

NORTHCOTE: 425 High St.
Phone (03) 489 8866

CLAYTON: 56 Renver Rd.
Phone (03) 543 7877

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Electronic Discounters P/L,
305 Morphett St, ADELAIDE
Phone (08) 212 1799
NOTE: (Prices may vary interstate due to freight costs)

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Interstate Orders: (008) 33 5757
All Inquiries: (03) 543 7877

CORRESPONDENCE:
P.O. Box 620, CLAYTON 3168
Telex: AA 151938
Fax: (03) 543 2648

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
(STRICTLY ORDERS ONLY)

LOCAL ORDERS & INQUIRIES (03) 543 7877

POSTAGE RATES:

$1	$9.99	$2.00
$10	$24.99	$3.00
$25	$49.99	$4.00
$50	$99.99	$5.00
$100	$199	$7.50
$200	$499	$10.00
$500 plus		$12.50

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

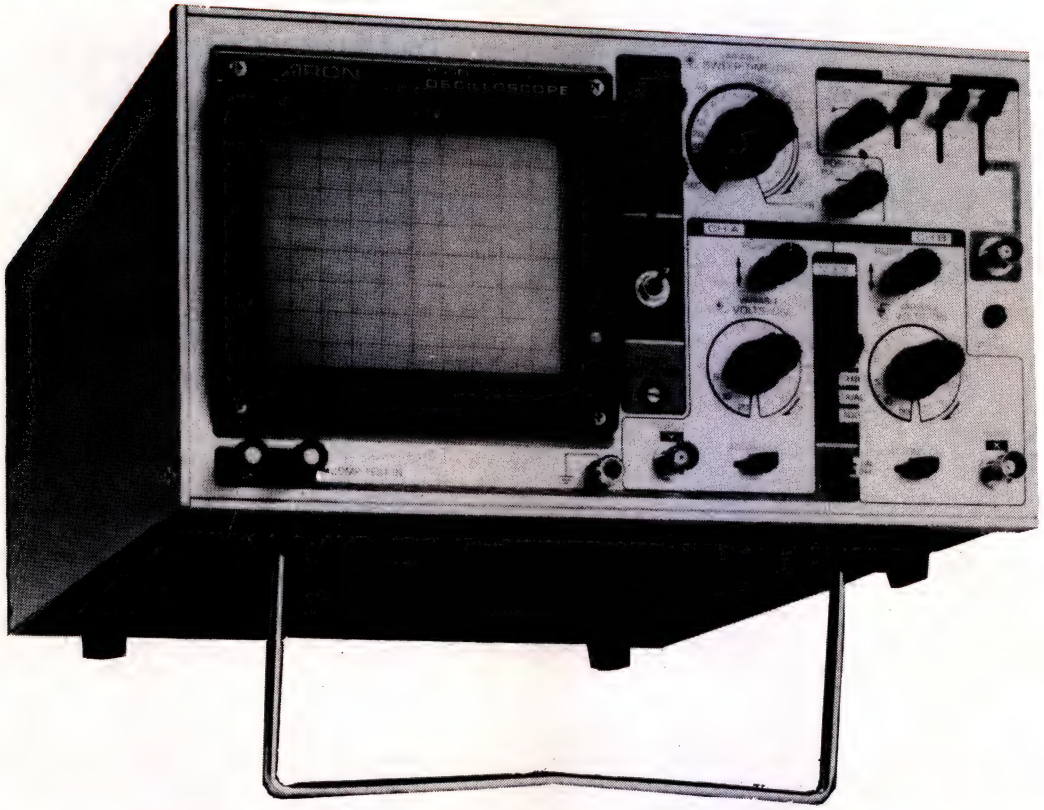
All sales tax exempt orders and wholesale inquiries to: RITRONICS WHOLESALE, 56 Renver Rd, Clayton. Ph. (03) 543 2166 (3 lines)

Errors and omissions excepted Prices and specifications subject to change

MasterCard VISA

3RD BIRTHDAY CONTEST No.6.

Servicemen – Enthusiasts. COP THIS!



You could win an Aaron dual-trace 20 MHz CRO with built-in component tester, model BS-601. Nearly $900 value!

1) Where does the 'cathode dark space', or 'Crooke's dark space', appear in a cathode ray tube?

. . . . . .

2) In 1967 Elmeasco Instruments commenced operations in small offices in a well-known Sydney suburb. Which suburb was this?

. . . . . .

3) What shape would you expect to be displayed on the Aaron BS-601 oscilloscope if a capacitor were being tested using the component tester?

. . . . . .

How would you put the Aaron dual-trace 20 MHz CRO to good use? Tell us in 25 words or less.

I have read the rules of the contest and agree to abide by their conditions.

Signature:_____

Name:_____

Address:_____

_____ P/Code:_____

Phone: (___) _____

Here is a golden opportunity to own this versatile general purpose 20 MHz CRO from Aaron. It boasts a large 150 mm flat-faced high brightness CRT with internal graticule. The two inputs may be displayed separately, added or inverted. The trigger coupling mechanism features TV Sync Vertical and Horizontal Sync Separator Circuitry, which allows any portion of complex TV video waveforms to be synchronised and expanded for viewing.

Vertical sensitivity can be set between 5 mV – 20 V per division, in convenient 1-2-5 steps. Horizontal calibration is between 0.2 μs – 0.5 seconds per division, with the sweep magnifier providing 5x enlargement for clearer viewing of complex waveforms.

The in-built component tester quickly and easily displays graphically the characteristics and values of components such as resistors, diodes, capacitors, individual transistor junctions etc., unambiguously showing where any fault may lie. Semiconductors can be matched for similar characteristics, and suspect components can be tested without the need to apply power to the circuit.

Prize kindly donated by Elmeasco Instruments Pty Ltd.

GREAT READER OFFER!

HANDY 'POCKET' TESTERS

FEELING TESTY?

If so we have just the thing for you.

AEM, in conjunction with Aliette Pty. Ltd., are able to offer two incredibly useful and unbelievably priced test devices.

The PAMA Combi-Sensor

This unique device allows you to test whether or not a particular device or conductor is live, WITHOUT dismantling the device or stripping any wires. The Combi-Sensor is so sensitive it will detect voltages as low as 20 Volts.

It does this by detecting the associated field that is apparent when a voltage is applied to a conductor. The Combi-Sensor is as simple to use as your household torch, just place the end of the device near the object under scrutiny and press and hold the button on the top of the sensor. If a voltage, be it ac or dc, is present the Combi-Sensor will beep and an indicator LED will light.
What could be more simple?

A great buy at $34.95!

The TESTER PLUS

On first appearances the Tester Plus looks like a modern version of the neon screwdriver of old. However, DON'T judge a book by its cover!

The Tester Plus does everything its neon counterpart did AND MORE!

Not only can you check whether or not a power point is live, the Tester Plus is a ONE-PROBE continuity tester. To check, say, the continuity of a length of wire, all that is required is to hold the Tester Plus screwdriver with your thumb in contact with the metal plate on the side, touch one end of the wire with the tester's probe and the other end with your remaining hand. So easy even Uncle Fester can use it!

The Tester Plus has hundreds upon thousands of applications for the serviceman, enthusiast and professional alike. Battery and semiconductor testing, continuity check, voltage testing, automotive uses, repairing the boat – the list goes on!

How could you miss at $14.95!

AEM is acting as a clearing house for both the Combi-Sensor and the Tester Plus and we have been advised that there are a limited number of units available, *SO GET IN QUICK!*

Offer Closes 30 September 1988.

There are two quick, convenient ways to order one or both of these unique test instruments.

EITHER

Send the coupon with a cheque or money order, to:

AEM Testers Offer,
1st Floor, 347 Darling St.
BALMAIN 2041 NSW.

OR

'PLEDGE your PLASTIC'
by phoning (02)555 1677 during office hours and giving Ingrid your credit card and address details.

PAMA COMBI-SENSOR

(PAT. PENDING)

MAIN FEATURES

- Solid state reliability
- Safe in use
- Simple in application. Used with equal ease by skilled electricians and housewives
- No test leads
- Handy and useful.

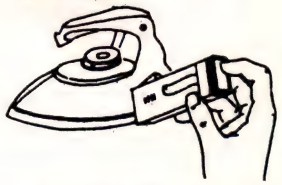
$34.95

Combi-Sensor is equipped with a test light and a sound emitting buzzer, and is operated by two standard AA batteries.

SOME OF THE SUGGESTED APPLICATIONS

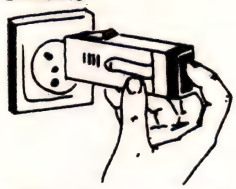
A – Detecting Live Conductors (Voltage Presence Test)
Press your Combi-Sensor slightly to the insulation of the tested conductor and push the button. If the tested conductor is live, Combi-Sensor will indicate it clearly by glowing test light and by continuous buzzing.

B – Testing Connection to Ground



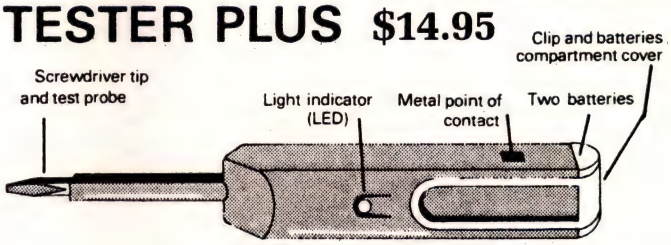
The tested electrical appliance should be switched on. Press your Combi-Sensor slightly to the appliance's surface and push the button. If the tested appliance is not grounded, Combi-Sensor will indicate it immediately by glowing test light and by continuous buzzer.

C – Wall Outlets and Switches



Press your Combi-Sensor slightly to the surface of the tested outlet or switch. Push the battery button. If the outlet or switch is live, Combi-Sensor will indicate it by continuous response of test light and buzzer.

TESTER PLUS $14.95



Yes, please send me the following quantities of the Combi-Sensor and/or the Tester Plus!

. . . . . Combi-Sensor(s) at $34.95 each.

. . . . . Tester Plus(s) at $14.95 each.

plus post and handling $3.00. per order.

I am paying by:

☐ Cheque ☐ Money Order ☐ B/Card ☐ M/Card ☐ Visa

Cheque/Money Order No.:_____

Credit Card No.:_____

Signature:_____
(unsigned Credit Card orders cannot be accepted)

Name:_____

Address:_____

P/Code:_____

Phone No.: (___) _____

Applying the ZAP test to ICs!

Hartley Measurements Limited has announced the availability of the Device Analysis Program for use with their AUTOZAP IC tester which will apply reproducible pulses of energy from a human body model to the required pin of the component under test.

The *threshold* test correlates the voltage/current characteristics before and after the pulse. The user is able to define the pass/fail criteria of the device and if the characteristic has changed by a predetermined amount the device is designated as damaged.

If no damage has occurred the voltage is increased in steps until damage *is* detected or the voltage reaches the maximum required value. This process is repeated until all pins have been tested.

The results of the test may be printed out in bar chart form, providing a very clear and unambiguous indication of the particular device's immunity or otherwise to damage by static discharges.

ETP-Oxford P/L is the local distributor of the Device Analysis Program. They can be contacted at **31 Hope St, Ermington 2115 NSW, (02)858 5122, or 214 Berkeley St, Carlton 3052 Vic., (03)347 0733.**

Rebel finds a cause

Rebel Audio P/L has announced that they are now the Australian distributors for the Astatic range of microphones from the USA.

Astatic's commercial range of microphones has found wide acceptance in many installations in the USA. The range includes dynamic/electret gooseneck, podium and vocal microphones, touch-to-talk, conference, and wall-mount microphones.

Rebel are confident that they can offer commercial or sound contractor customers a good value microphone to suit most applications.

For more information contact **Rebel Audio P/L, 286 Great North Road, Five Dock 2046 NSW. (02)713 6866.**

New Fairchild distributor

Following the acquisition of Fairchild by National Semiconductor Corp., IRH Components has been appointed Australasian distributor of the Fairchild range of semiconductors.

The range includes FACT and FAST logic families, zener diodes, signal diodes, voltage regulators, op-amps and transistors.

IRH has commenced the process of stocking the wide range of Fairchild semiconductors in their Sydney warehouse. They can be contacted on **(02)648 5455.**

Semicrystalline solar cells

Solarex P/L has succeeded in the development of large area semicrystalline cells which produce higher voltage and current than was previously possible.

The new Solarex MEGA series of modules are a direct result of over ten years of R&D in semicrystalline silicon casting and enhancement techniques.

The MSX58 and MSX54 modules produce 3.75 and 3.5 amps at 14 volts nominal, with a peak power rating of 58 and 54 watts respectively.

A single MEGA module can be used in place of two standard modules in many instances, saving module costs as well as providing savings in wiring, support structures and surface area required.

The Solarex manufacturing facility at Villawood, NSW has been retrofitted to produce the new MEGA modules, and mass production runs are under way.

For more information contact **Solarex P/L, 78 Biloela St, Villawood 2163 NSW. (02)727 4455.**

Customised battery packs

Premier Batteries P/L has introduced a customised battery fabrication service for high technology applications.

Using high performance lithium or NiCad cells, the battery packs should find use in the communications, broadcasting, computer, avionics, defence and medical fields.

For applications requiring high performance packs, Premier provides close-tolerance capacity matching of the cells before they are made up into packs. The inclusion of unmatched cells in a battery of this type would introduce a weak link into the system, reducing the performance of the whole battery relative to the poorest cell, and increasing the possibility of driving that cell into reverse polarity.

The range of lithium thyonyl chloride batteries offered by Premier have up to ten times the energy of conventional NiCad or ZnCl batteries, with a shelf life of more than ten years and a proven 15 years for the LC series.

Premier can also supply sintered plate cells for particularly rapid drain functions such as starting of aircraft engines.

If your device needs a custom-made rechargeable battery pack, contact **Premier Batteries P/L, Unit 7, 27 Childs Road, Chipping Norton 2170 NSW. (02)726 7701.**

Local fibre optics manufacturer wins Telecom business

Alcatel-STC Cannon Australia manufactures and distributes a wide range of connectors for telecommunication, military, computer, medical, automotive and audio applications.

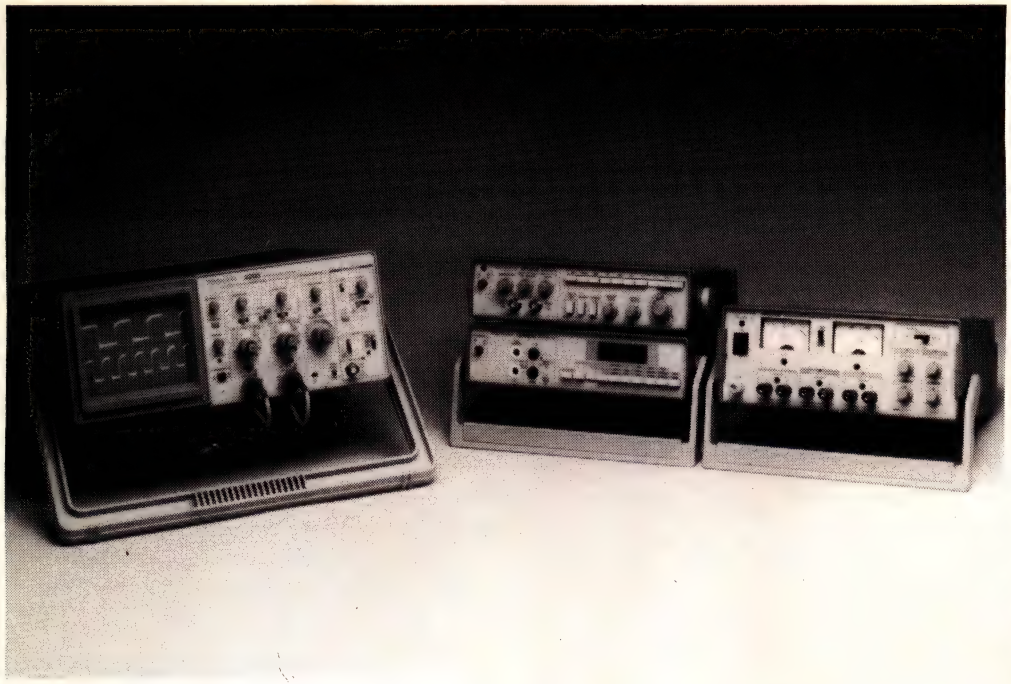
They are Telecom Australia's preferred supplier of fibre optic connectors, which accounts for almost one quarter of the company's business.

Since its affiliation with the world's largest optic connector manufacturer, Diamond SA of Switzerland, the company has managed to capture 70% of the Australian market, they claim.

Connecting a single mode fibre optic cable, which is considered state-of-the-art in fibre optic technology, to a connector requires extreme accuracy – a vital issue for Telecom. Diamond originally devised the way of providing that accuracy for single mode cabling, which requires physical contact between fibre optic cables.

Alcatel-STC's success with Diamond's products, illustrated by the establishment of a new $250 000 manufacturing facility in Moorabin Vic., should enable them to continually provide quality products to the Australian and export markets.

Alcatel-STC Cannon can be contacted at **PO Box 488, North Sydney 2060 NSW, (02)925 7272**



Bench instruments for educational use

Tektronix Australia P/L has announced their Classroom Series (CRS) of bench-top laboratory quality instruments, intended specifically for use in educational institutions.

Research in the USA revealed a definite need for industry-quality electronic instruments in the classroom to fulfil the training requirements of a whole new generation of technicians and engineers. However, there was a contradictory lack of funds in the very schools and colleges which needed the equipment the most.

Tektronix developed the CRS range in order to supply industry standard equipment at a price that education authorities could afford.

The Basic Lab 1, designed for beginning students, consists of the 20 MHz Model 2205 oscilloscope, a power supply, function generator and digital multimeter. For advanced students, the Basic Lab 2 offers a 50 MHz Model 2225 oscilloscope and adds a frequency counter to the set.

The oscilloscopes combine rugged design, safety and ease of use, as well as featuring industry-standard front panels and controls. This enables students to transfer classroom knowledge to the workplace with a minimum of retraining.

The CRS range of instruments is supported by teaching aids designed by Tektronix with the assistance of experienced educators. Operating manuals are written at the appropriate level, with careful consideration given to vocabulary and technical detail. Video tapes and primers are presented which fit easily into lesson plans. Lab exercises are provided to help students learn useful measurement techniques.

Support materials can be selected from a comprehensive catalogue which lists all the printed and A/V material in the range. These materials can be ordered separately, and many are available free of charge for review in single copy quantity.

For more information contact **Tektronix Australia P/L, 80 Waterloo Rd, North Ryde 2113 NSW. (02)888 7066.**

Plessey pushing their piezoelectric crystals

Darling Harbour's Sydney Convention Centre will be the venue for *Austceram 88*, the 1988 International Ceramic Conference and Exhibition, being held from August 22nd to 26th.

Plessey will be exhibiting the results of their extensive research and development into piezoceramics at the conference. They are one of the leading companies in the Asia-Pacific region manufacturing piezoceramic-based acoustic devices.

Ceramics that lack a centre of symmetry in their crystal structures often possess the property of piezoelectricity, which means they generate electric polarity when subjected to a mechanical stress and, conversely, generate stress when a voltage is applied to them.

The numerous applications for piezoceramics include: mechanical positioners and relays, impact ignitors, loudspeaker tweeters, ultrasonic medical devices, and marine sonar hydrophones and transducers.

Since weak piezoelectric impulses must be preamplified at the transducer level, Plessey also designs and manufactures hybrid microcircuits for that task. Such products will be on display at Austceram 88, including the Barra Hydrophone, a revolutionary hydrophone produced under contract for the RAAF in Australia and supplied to the RAF in Britain.

Plessey's manufacturing facility produces piezoceramics from raw materials, to their own designs, at their complex in Sydney. The research centre includes the only underwater acoustic testing facility in the Australian industry.

Three papers on the optimisation and composition of piezoceramics will be presented by Plessey staff at Austceram.

For further information contact Harley Tracey, at **Plessey Australia P/L, Faraday Park, Railway Rd, Meadowbank 2114 NSW. (02)807 0400.**

Gestetner makes an impact

Impact Systems, the renowned Australian producer of laser printers, has been acquired by AFP Investment Corporation Limited. Gestetner Lasers P/L, a wholly owned subsidiary of AFP, has been formed to carry on the business of Impact.

A substantial number of Impact's former employees, with the exception of senior management, have been employed by the new company. Sales, research and development and manufacturing will all be conducted at the original Impact Systems premises in Chatswood, NSW.

Through its acquisition of Impact, Gestetner's product line now includes an 8-page per minute printer for the PC and mini-computer market and the L2000 20-page/min. shared resource laser printer. Plans are made to release what is claimed to be the world's first true second generation 8-page/min. laser printer on the 1st of July this year.

Within two days of the new company's debut, laser printer orders in excess of A$1 million were negotiated with Gestetner Data Systems in Europe, with a similar value of local orders already negotiated for immediate delivery.

Gestetner is confident of duplicating this success over the next twelve months of trading. They can be contacted on **(02)406 6611.**

Fujitsu chooses Schlumberger

Fujitsu Australia has selected local company Schlumberger Technologies P/L to supply Automatic Testing Equipment (ATE) for their new Dandenong plant.

Fujitsu are investing $30 million to build a complete production facility for high complexity PCBs and computer-related equipment. Being anxious to maintain their good reputation for hardware reliability, Fujitsu have envisaged a highly automated plant with sophisticated automatic testing facilities.

Schlumberger, a highly respected supplier of Automatic Test Equipment, is well-equipped to supply the system required, which is capable of testing complex printed circuit assemblies with up to 300-400 devices per board within one minute.

Charge coupled devices

Alan Denby

Originally conceived as an alternative to bubble memory in digital storage applications, the charge-coupled device has recently found wide application as the principal optical sensing device in small, lightweight video cameras. Here we examine the principles behind their operation, the types available and other applications for this versatile family of components.

CHARGE-COUPLED DEVICES (CCDs) belong to a family of solid-state devices called Charge-Transfer Devices (CTDs). This family of devices also includes Bucket Brigade Devices (BBDs). In essence they are simple devices which work as a shift register formed by a string of closely spaced MOS capacitors. They can store and transfer analogue-charge signals, either electrons or holes, that may be introduced electrically or optically.

CCDs are a recent innovation, having been developed in 1970 by W.S. Boyle and G.E. Smith at Bell Laboratories. They were looking for an equivalent to magnetic bubble memory which could be manufactured in silicon and could take advantage of the well developed silicon technology. These devices have found use in many fields including image sensing, analogue signal processing and memory applications.

The idea of using capacitors as a means of storing information is not new. In 1952 Jansen proposed a system of ideal buffer amplifiers and switches which could be used to transfer information. In 1965 these circuits, shown in Figure 1, were implemented to provide a variable analogue delay. These circuits were known as Bucket Brigade Devices. In 1967 the idea was revised and implemented with bipolar transistors, and subsequently with MOSFETs.

A CCD cannot be represented by discrete components, but operates in much the same way as a BBD. CCDs are in fact closely spaced capacitors on an isolated surface of a semiconductor. The capacitor electrodes, when pulsed in the proper sequence, generate a series of moving potential wells which can carry packets of minority carriers.

The MOS capacitor

The basic element of many CCDs is the MOS capacitor. Figure 2(a) shows a MOS capacitor formed by a metal electrode attached to a thermally oxidised p-type silicon substrate. If a positive voltage is applied to the electrode the majority carriers are repelled and a potential well is formed at the surface which is initially depleted of free carriers. Minority carriers, electrons in this case, are thermally generated in or near this well, and accumulate at the interface.

Even though the charge accumulates at the interface it is convenient to think of the potential well as being a bucket, and the minority charge as a fluid that partially fills it, as depicted in Figure 2(b).

Surface Channel Charge-Coupled Devices (SCCD)

If two MOS capacitors are placed close together so that their depletion regions overlap, any mobile minority charge will tend to accumulate in the region of highest potential. In terms of the "bucket" model this means that the fluid will flow to the deepest part of the potential well. If a charge packet is present in a potential well it will spread over this well and into the adjacent one if it is at an equal or greater potential, as depicted in Figure 3a and b. By stringing together several such devices a number of charge packets can be transferred at the same time.

To ensure that transfer is only in one direction three- phase clocking is required. By using asymmetrical electrodes a two-phase clock can be implemented. In some situations a four-phase clock is required. In this type of CCD the charge is contained in two adjacent potential wells, thus doubling the signal that can be transferred by the device.

Bulk channel Charge-Coupled Devices (BCCD)

SCCDs store the charge at the silicon-silicon dioxide interface. This can limit the performance due to the interaction of the charge with interface states. This problem can be overcome by the use of bulk channel CCDs.

A layer of silicon of opposite polarity to the substrate is implanted at the surface and shifts the region of maximum potential away from the interface and into the bulk. This layer is in electrical contact with the input and output diodes of the CCD, which drain out all mobile carriers under a suitable reverse bias. This forms a large potential well in the form of a depleted bulk channel. Mobile signal charge will reside near the potential maximum. The clock pulses applied to the electrodes will modulate the channel potential and give rise to the moving potential wells which can store and transfer charge packets.

There are three methods by which a charge packet can be placed into a potential well. These are *dark current, photoelectric carrier generation* and *electrical charge injection.* Dark current is a source of noise and signal degradation and therefore photoelectric generation is the method used in CCD imaging arrays.

There are several methods of electrical injection, all of which employ an input diode. The simplest form is *dynamic current injection,* where a signal is applied to the input diode with reference to the potential of an input gate. The first potential well is then pulsed, and charge transfers from the diode across the input gate and into the well, as depicted in Figure 4(a). This method, however, has poor linearity as it depends on the gate potential, the depth of the potential well, the pulse time and therefore the clock frequency.

Diode cutoff, illustrated in Figure 4(b), is a better method which fills the first potential well with signal from the input diode while the input gate is open. The gate is then turned off and the charge packet is isolated from the input diode ready for transfer.

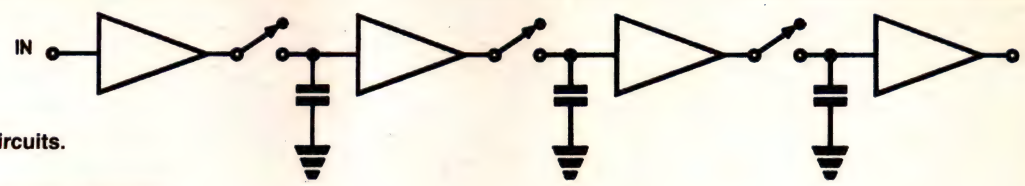
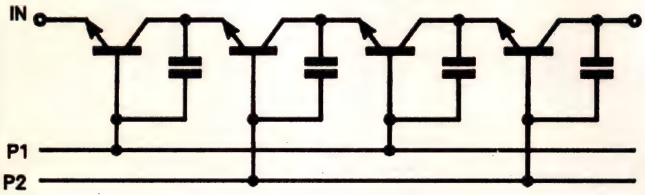
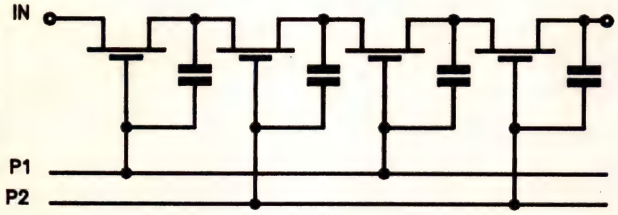


Figure 1. Charge transfer circuits.

a) IDEALISED BUFFER AMPLIFIERS



b) BIPOLAR BUCKET BRIGADE



c) MOSFET BUCKET BRIGADE

Figure 2. A MOS capacitor.

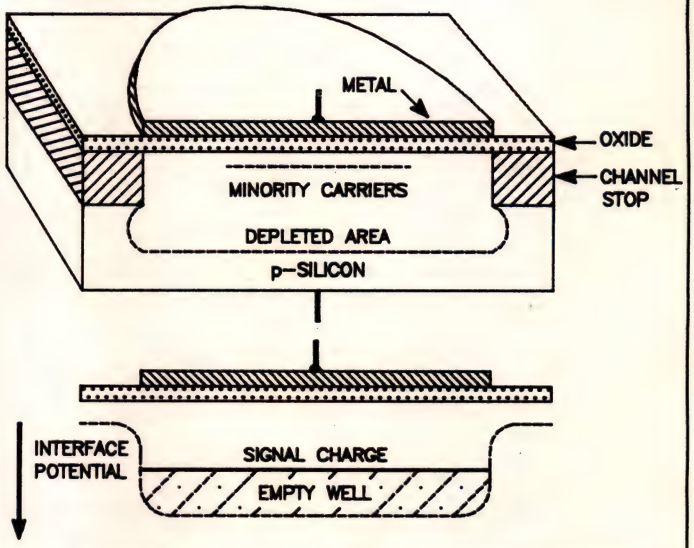
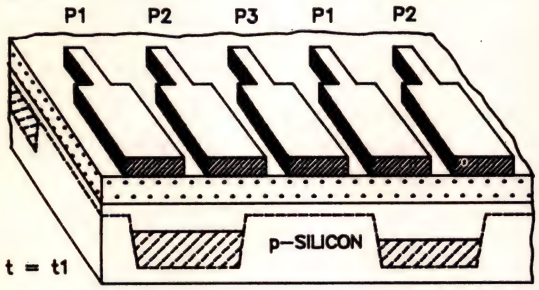
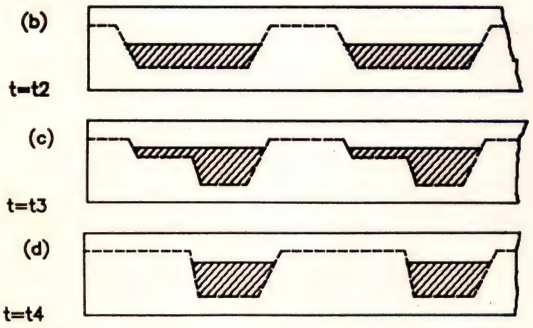


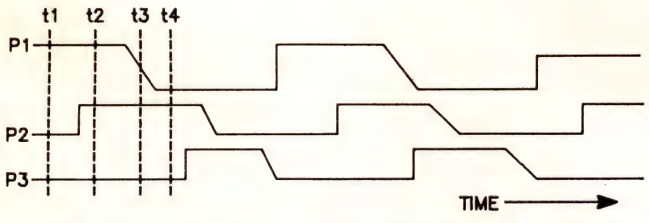
Figure 3. Schematic rendering of a three-phase n-channel CCD.



(a) Charge–carrying potential wells in the cross section of the silicon substrate

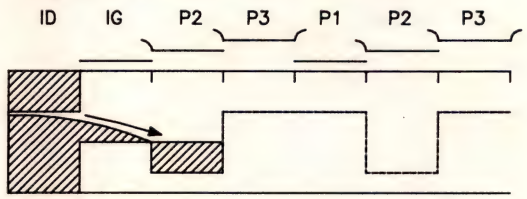


(b,c,d) Potential wells shown at subsequant time intervals illustrating the transfer of charge.

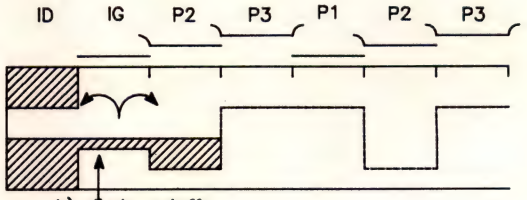


The corresponding time slots marked in the clock waveforms

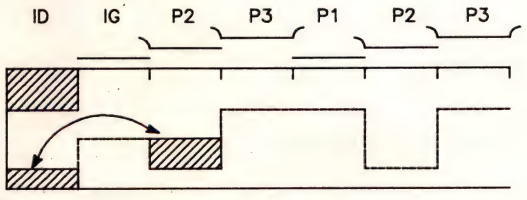
Figure 4. CCD Input/Output methods.



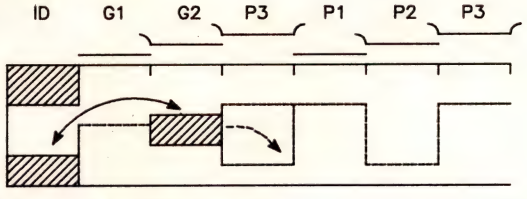
a) dynamic current injection



b) diode cutoff



c) potential equilibrium



d) improved equilibrium method

Figure 4(c) shows a third method, *potential equilibrium* (or "fill-and-spill"), which involves alternately pulsing the input diode, to overfill the first potential well, and then draining off the excess to the level of the input gate.

An *improved equilibrium* method is depicted in Figure 4(d). This uses a second input gate in conjunction with potential equilibration. The second gate is held at a constant potential, and less input noise is generated because this gate is not clocked. Experimental results indicate that this method offers the best linearity, and low noise.

Output signal detection can be accomplished by passing the charge into the depletion region of an output diode where it is sensed by a current-sensitive amplifier. This method is destructive, and the charge signal is lost once read. A second, nondestructive method detects potential changes on the floating gate of a MOSFET output transistor. By using non-destructive detection the charge packets can be sampled at several intervals along the CCD array. This has applications in signal processing.

Noise signals

An important consideration in CCDs is their ability to transfer charge packets from one potential well to the next without altering the signal in any way. Each time charge is transferred

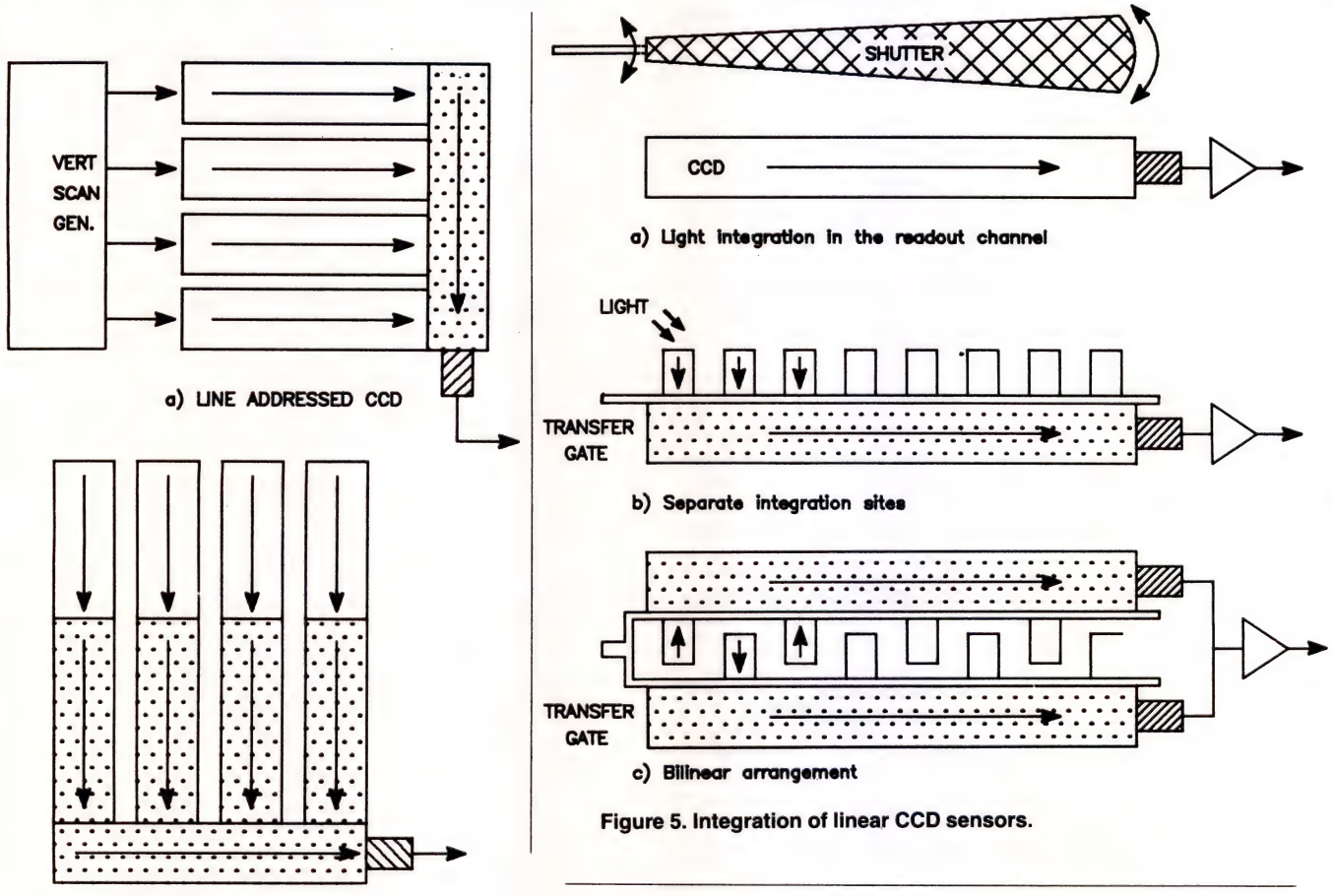


Figure 5. Integration of linear CCD sensors.

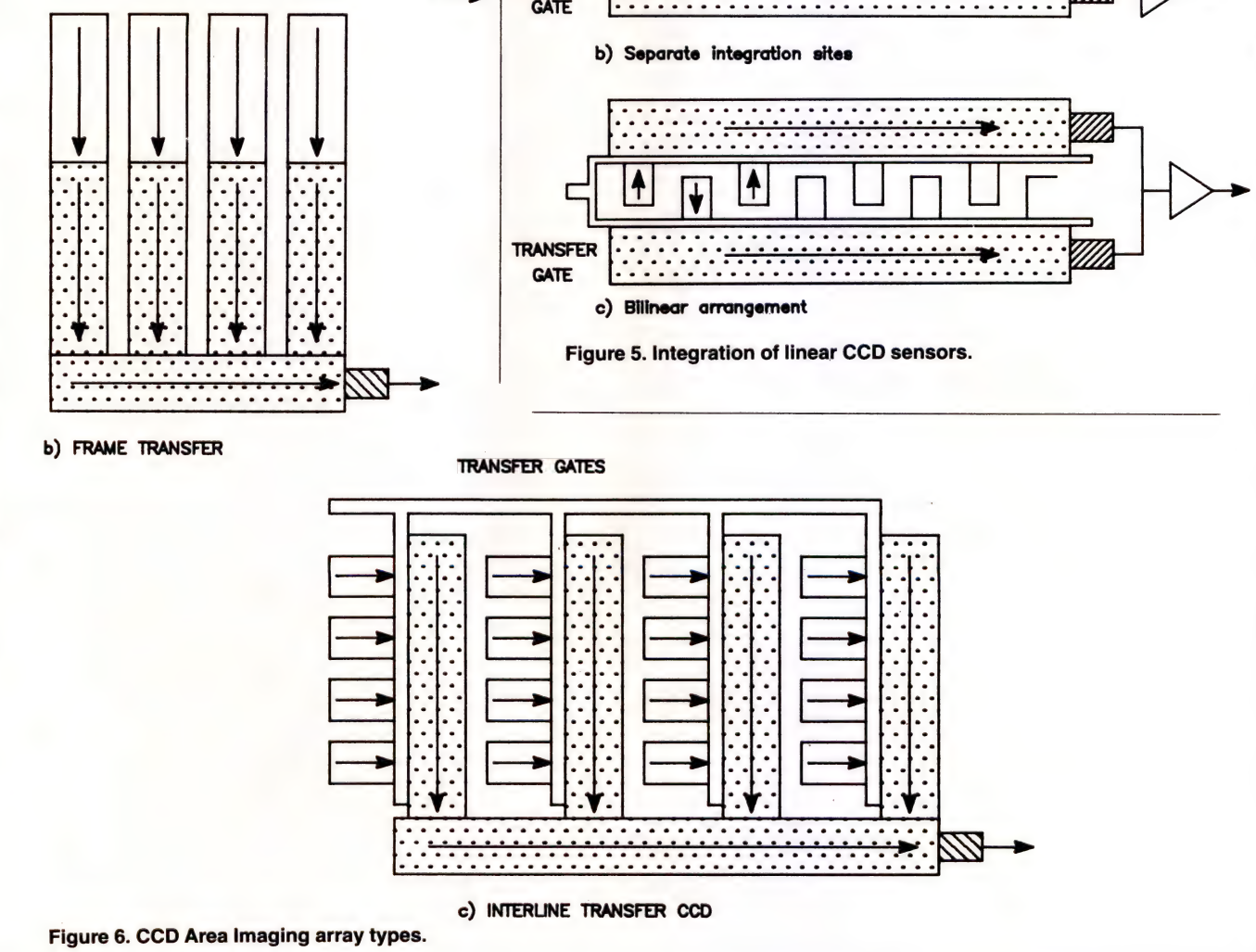


Figure 6. CCD Area Imaging array types.

a small portion may be left behind or some additional charge may be added.

Transfer efficiency (n) was originally defined as the fraction of charge that was transferred correctly from one well to the next. In some cases it is also used to describe the difference between the input and output signals for the complete device.

It is also convenient to define the transfer inefficiency [E] = (1 – [N]). Thus the inefficiency product for a CCD containing *n* cells is *n*[N]. Transfer inefficiencies for single cells of between 10^{-3} and 10^{-4} are not uncommon.

The signal that is left behind at each transfer accumulates in the potential wells to produce transfer noise. This noise signal is influenced by input signal level and clock speed, as well as some random fluctuations. Transfer noise is also contributed to by interface state noise in SCCDs and bulk trap noise in BCCDs.

Integration noise occurs during the period that charge is stationary in a potential well. This can take the form of *dark current noise*, where electron-hole pairs are generated in the potential well, or *thermal noise*. In image sensing devices, integration noise is caused by incident light. Noise can also be generated by the input and output sampling circuits of the CCD.

In order to minimise the effect of transfer noise and integration noise, a small charge packet that corresponds to a zero input sample is introduced into the CCD. This is known as a *Fat Zero* and is typically 10% of the maximum charge packet.

CCD image sensors

Some of the first experiments with CCDs involved the imaging of visible light. These early CCDs had no region into which charge could be injected, and the potential wells were filled by generation of electron-hole pairs from incident photons.

As image sensors, CCDs offer many advantages over the more conventional vidicon tube. These advantages include low thermal noise, low light level performance, flat spectral response, low cost, small size and low power consumption.

There are two basic types of CCD imaging devices. The *linear imaging array* consists of a single row of photosensitive elements, and the *area array* has these elements arranged in a two-dimensional matrix.

Linear image sensors

These devices are used as one-dimensional sensors for such applications as the measurement of fluid depth in tanks. To achieve two dimensions with a linear array the second dimension must be mechanically scanned. This may be done with a rotating mirror or more often by moving the object to be scanned over the array. With this type of device resolutions of several million points can be obtained. Linear arrays are found in many modern facsimile transmission systems.

The simplest form of linear array, shown in Figure 5(a), is one in which integration occurs in the transfer channel. This type of device must be clocked so that shift-out time is very much less than integration time. If not, smearing problems will arise when charge is transferred through light-sensitive regions. One method of overcoming this is to place some form of electrical or mechanical shutter over the array during the transfer process.

A better method of overcoming smearing is to use separate sensors and readout registers, as illustrated in Figure 5(b). After integration is completed the charge packets are shifted into the register which is clocked out during the next integration period. The shift register is not exposed to the incident light, which helps to eliminate the problem of smear.

A third type of linear array, shown in Figure 5(c), is constructed from a separate sensor and two shielded readout registers. Odd elements are shifted left into one register and even elements are shifted right into the other. These can be clocked out and recombined. The major advantage is that half the number of transfers is required to read any one element or pixel.

The first commercially available linear array consisted of 500 elements with a cell length of 60μm and separation of 30μm. Thus it had a total length of 45 mm. More modern linear arrays have a sampling pitch of 5μm, and contain 5732 sensor elements. This represents a tenfold increase in image resolution.

Area imaging arrays

In order to generate real-time pictures at the required rate for broadcast TV and other video applications, the CCD must be scanned electronically in two dimensions. The simplest method is the *line addressed CCD*, as shown in Figure 6(a). In this method a number of linear sensors are arranged in a two-dimensional array. A common readout register can then be used to access the charge information. This system is both slow and prone to smearing.

A better approach is that of a *frame transfer CCD array*, as depicted in Figure 6(b). This involves the use of vertical rows of imaging cells to form a two-dimensional array. A second array of the same size, which is shielded from the light source, is required below the imaging area. The exposed area is integrated, then during the vertical retrace period of the video signal the whole array is shifted quickly down into the shielded area.

When the transfer is complete the upper region starts integration for the next frame. During each horizontal blanking period the stored area of signal is shifted down one row at a time into the shift register. When this signal is shifted out horizontally it forms the video signal. After complete transfer of the stored area the next image is then ready for frame transfer. The simplicity of the electrode arrangement offsets the problems associated with the need for an extra storage area and the smearing or blooming effects that can occur.

The first frame transfer CCD had a resolution of 106 x 128 pixels and used three-phase clocking. Recently a high density 604 x 576 pixel frame transfer CCD with antiblooming structure was released.

Interline transfer arrays, as shown in Figure 6(c), allow charge to accumulate at separate integration sites before each element is clocked horizontally into a vertical shift register. This requires only one transfer to remove the whole frame from the light-sensitive area.

During each horizontal blanking period the vertical shift registers shift one line down until they have all been read out, at which point integration of the next frame is completed, and the transfer process is repeated during the vertical retrace. By designing two integration sites for each element of the vertical register it is possible to achieve the required interlacing by transferring the charge from alternate sites. This type of CCD array is simple in operation, but requires more complex cell design and reduces the light-sensitive area because of the need for light shields over the transfer channels.

The first commercially available CCD interline image sensor was a 100 x 100 pixel device. It had sensors measuring 18 x 14μm and employed bulk channel registers. More recently, a 17 mm CCD interline transfer image sensor was developed with 768 x 490 pixel resolution and 1.5μm element pitch.

The most important parameter in imaging arrays is the signal-to-noise ratio. Bulk channel devices are best suited for low noise applications.

Colour CCD sensors

The first colour camera employing CCD imaging devices was demonstrated in 1973. This used three 106 x 128 element CCDs and a beam-splitting prismatic assembly of dichroic

mirrors. The light was filtered into the three primary colours, each of which fell onto individual CCD targets.

Modern CCD cameras employ single-chip sensors. These devices contain colour filters on their surface. The filters can be arranged in vertical stripes or in a chequerboard pattern, depending on the type of device and its application. With frame transfer devices the colour filters are usually arranged in vertical stripes of red, green and blue (RGB). Each coloured row is transferred into its own horizontal shift register to separate the three colour signals.

The relative colour intensities must be matched, and in some cases two green stripes may be present for each pair of red and blue. This gives the filter an RGBG pattern.

With interline transfer devices a chequerboard pattern of red, green and blue filters is more often used. Because of the precise control and transfer that can be achieved with digital clocking, it is not difficult to reconstruct the colour matrix into the required colour components of the video signal.

Each colour pixel is comprised of three or more individual sensor elements. To achieve the same resolution as a monochrome sensor the packing density of the sense elements must therefore be three or four times greater. This is the main reason that colour CCD cameras are not widely used in broadcast applications.

A number of near-broadcast-quality three-chip colour cameras are currently available. These replace the three conventional vidicon tubes with CCD sensors.

Infra-red CCD sensors (IRCCD)

These are of two types, *monolithic* and *hybrid*. The monolithic IRCCD has the CCD substrate constructed of an IR sensitive material. The IR source causes photo-emission directly in the potential wells of the CCD. With hybrid types the IR radiation is sensed by an array of IR detectors of any suitable material, and these are interfaced with the silicon CCDs which perform the readout.

Modern IRCCD image sensors use Schottky-barrier detector arrays in a monolithic structure for image sensing in the short wave IR ($1-3\mu m$) and for thermal imaging applications in the medium wave IR ($3-5\mu m$). These devices have applications in the areas of military, surveillance, medicine and astronomy. IRCCDs are being used in the Hubble Space Telescope, which is to be launched when shuttle flights resume.

IRCCDs are also under development at the University of NSW, where they have been used in conjunction with the Anglo-Australian Telescope for imaging of stars.

CCD signal processing

The CCD is a sampled analogue device. Each charge packet represents the value of an analogue signal sample. The simplest form of CCD signal processor is the serial-input/serial-output device, which operates as an analogue delay line.

Although the delay line itself is a useful device, this is not the only signal processing application that CCDs perform. Serial-to-parallel and parallel-to-serial manipulations can be performed, making the device useful as a multiplexer/demultiplexer.

Clocking frequencies of 10 – 20 MHz are achieved with transfer inefficiencies of 10^{-4} to 10^{-5}. Some deep-buried channel devices have been clocked at frequencies of 200 MHz, and some experimental results suggest that a clock frequency of 900 MHz is possible. The transfer of charge is controlled by a digital clock which ensures precise timing of the CCD circuit.

Charge samples may also be sensed nondestructively at any point along the CCD by using floating-gate amplifiers. This is useful for transversal filter implementation.

The serial-input/serial-output (SI/SO) structure has applications as a coherent analogue delay, as depicted in Figure 7(a). It can be used as the delay component in recursive filters, and as a variable data rate buffer for time-base compression or expansion. CCDs have a charge dynamic range in the order of 10^4 to 10^5 and delay bandwidth products of a few thousand. The sampled nature of the device requires that some consideration be given to effects such as aliasing and aperture time.

Figure 7(b) illustrates the parallel-in/serial-out structure (PI/SO), which has application as a multiplexer, delay-and-integration (or delay-and-add) processor, or for transversal filters.

The SI/PO structure shown in Figure 7(c) is most useful for transversal filter applications. It has been used for spectral filtering, transform calculation, and convolution/correlation. The critical components are the sense amplifiers and the signal weighting circuits.

Figure 7(d) shows a combination of these structures, which can be used to obtain large delay-bandwidth products. Once the signal is past the initial input circuit it is handled entirely as charge packets.

Transversal filters as a general class of filter use time-delayed signals which are weighted and summed with the correct sign to produce a wide range of filter implementations with a finite impulse response. This may be achieved simply with CCDs by the use of nondestructive sense amplifiers and external weighting and summing circuits.

A more elegant approach to this problem is to use a CCD with a split electrode structure, as shown in Figure 8. The electrodes of one clock phase are split into two sections of varying size and are clocked together. The charge which flows into each portion of a split electrode is dependent on the size of the electrode and the signal charge flowing into the region under the electrode.

By measuring the difference in charge flowing into the two parts of the split electrode, nondestructive sampling and weighting are performed simultaneously. Since the P2a electrodes are tied together, as are the P2b electrodes, the summation is done automatically. The output of the transversal filter is simply the integral of the signal difference on the P2a and P2b clock lines. This is performed by the differential current meter.

Digital Charge-Coupled Logic (DCCL)

CCDs are inherently analogue devices, but can be used in digital applications. A nearly full charge well is used to represent a binary "1" and a nearly empty well to represent a binary "0".

Under these conditions input linearity is not important and a refresh circuit is easily implemented some distance along the CCD. Shift register implementation is straightforward, and the basic logic functions as well as some more complex functions are performed simply with CCD logic.

CCD memory

Although CCDs were originally intended for digital memory use, this is the area in which they have had least success. When used as a memory device access is obtained serially to any single bit, and can take a long time compared to RAMs. This longer access time means that they must be cheaper or have a higher bit density than RAMs if they are to be competitive.

A nonvolatile analogue memory device has been constructed using NMOS/CCD techniques. After 100 hours of storage, signals are attenuated to 60% of their initial value with a linear dynamic range of 35 dB.

What next?

The simple idea of moving charge packets around in semiconductors under the precise control of electrodes has led to a variety of extremely useful applications. The proces

• to page 7

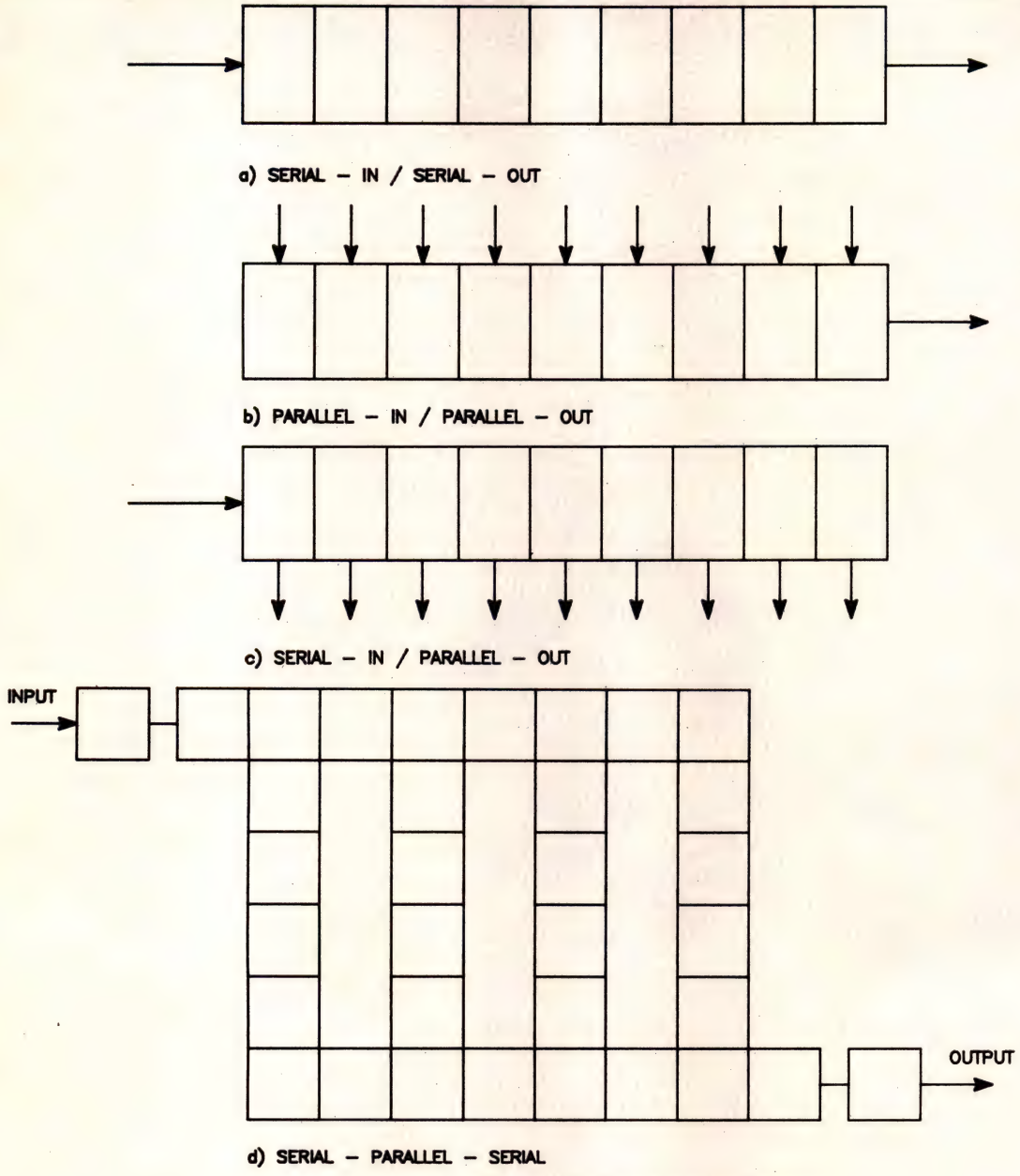


Figure 7. CCD signal transfer organisation.

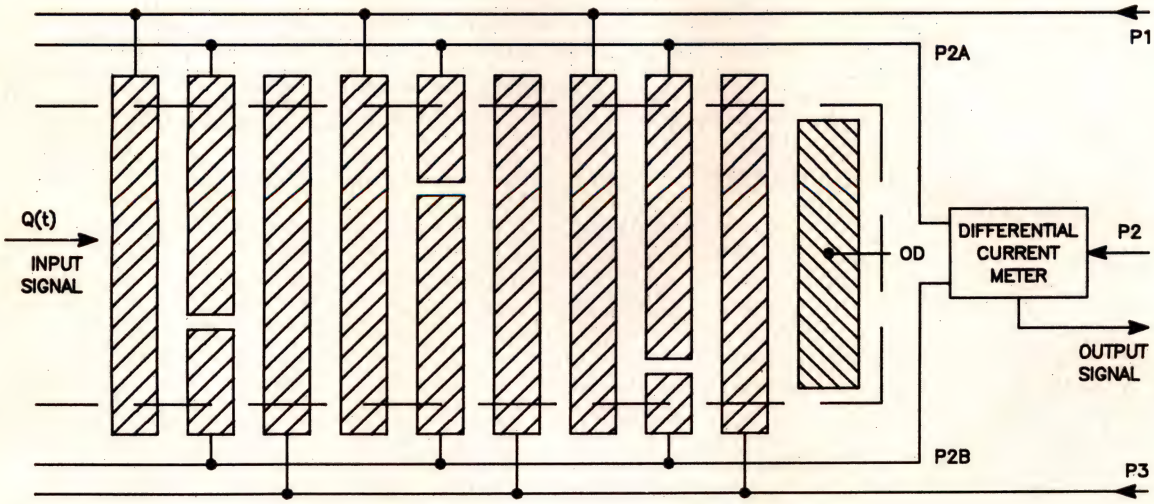


Figure 8. Split electrode transversal filter.

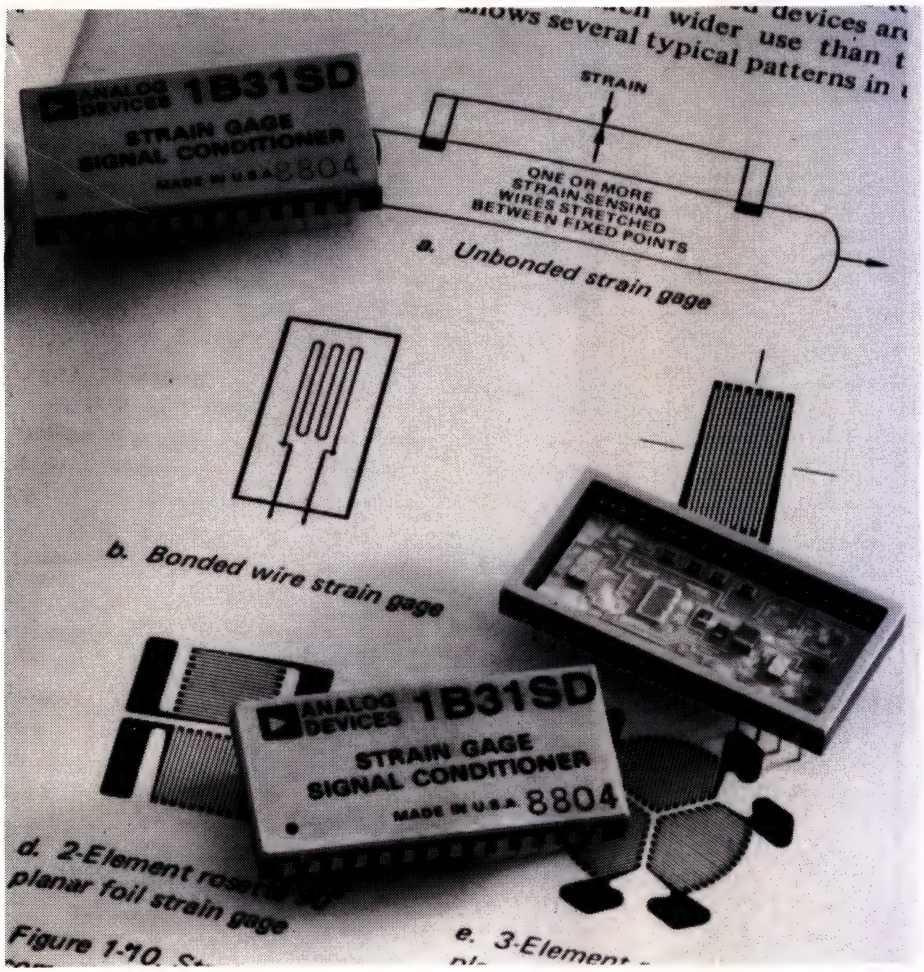


Figure 1-10.

Strain gauge conditioner

Analog Devices, represented by Parameters P/L, are offering a hybrid device which provides strain gauge excitation, amplification and filtering in a single compact package.

The IB31SD is specified over the –55 to +125°C range, is processed to US standard MIL-STD-883C for seam sealing and fine/gross leak testing with its bttom-brazed ceramic package with Kovar lid.

Bridge excitation supplied by the IB31SD is adjustable from +4 to +15 V, with an offset level of ±10 V. Gain is set by external resistors from 2 to 5000 V/V, with maximum nonlinearity of ±0.005%. Minimum common mode rejection ratio is 140 dB, and typical drift is ±0.25 V/°C. The device can drive a 350Ω load with a +10 V excitation.

The hybrid device is packaged in a 28 pin double-width DIP, and offers a far more compact and economical alternative to a discrete component device.

For more information contact **Parameters P/L, PO Box 261, North Ryde 2113 NSW. (02)888 8777.**

New Z80 support chips

Zilog has released two peripheral chips designed to provide extensive support for the Z80 (and other) processors, in highly integrated and compact packages. These new devices will allow designers to greatly reduce the number of components in microprocessor-controlled applications.

The two devices are: the Z84C90 Serial Parallel Counter Timer (SPCT); and the Z84C80/81 General Logic Unit (GLU).

The SPCT, tagged as a *multi-channel, multi-purpose peripheral device*, combines the features of Zilog's Counter/Timer circuit (Z84C30), Serial Input/Output controller (Z84C40/1/2/4), Parallel Input/Output controller (Z84C20), a byte-wide bit-programmable I/O port and a crystal oscillator.

Many high performance system applications can be configured with just the SPCT and a Z80, it is claimed. The SPCT incorporates a range of features not normally associated with peripheral support chips. These include two independent synchronous/asynchronous serial channels, three 8-bit parallel ports, four independent counter/timer channels, and an on-chip oscillator/driver. In addition, it supports the Z80-family interrupt daisy chain, as well as hardware and software driven resets.

The Z80 GLU *multipurpse interface controller* incorporates a clock oscillator and controller, dynamic random access memory (DRAM) interface and refresh controller, a static memory interface, power-on reset and synchronisation circuitry. The GLU operates with the Zilog Z8500 16 bit microprocessor as well.

Both chips are expected to find wide applications in consumer electronics or robotics applications where reduced size is a significant system design goal.

For further information contact **The George Brown Group, Marketing Division, 456 Spencer Street, West Melbourne 3003 Vic. (03)329 7500.**

CMOS switches and multiplexers catalogue

Parameters P/L have on hand Analog Devices Inc's new catalogue of CMOS switches and multiplexers. The 16 page booklet features product descriptions, block diagrams, reliability data and more.

The ADG series of switches and multiplexers operate anywhere in the +10 to +15 V single or dual supply range, and are well suited for applications such as disk drives, where only 12 V (±10%) supplies are available.

The price of the catalogue is right, *gratis*, and Parameters P/L can be contacted at **PO Box 261, North Ryde 2113 NSW. (02)888 8777.**

RISCy business

Tektronix has announced it will use Motorola's 88000 Reduced Instruction Set Computer (RISC) chip to extend the computing capabilities of its colour graphics workstations, making Tek the first workstation vendor to publicly commit itself to the new chip.

The 88000 product line extension is intended to complement the Motorola 68000 microprocessor family now used in the Tektronics 4300 series colour graphics workstations.

The 88000 is a three-chip set containing a primary processor and two cache memory management units. According to Motorola, it achieves 17 Million Instructions Per Second (MIPS) and 34 000 Dhystones, and generates more than 50 MIPS in multi-processor designs.

Tektronics found the Motorola 88000 superior to other RISC-based chips because of its multiprocessor, scalable architecture, and its single-chip implementation of both integer and floating point processors.

Tektronics are at **80 Waterloo Rd, North Ryde 2113 NSW. (02)888 7066.**

New GaAs PIN diodes

Alpha Industries' Semiconductor Division has announced the release of a new silicon nitride passivated GaAs PIN chip diode, the CGA3767.

Intended for use in UHF (and beyond) switching applications, the CGA3767 exhibits fast switching with low series resistance and capacitance characteristics.

The low series resistance, Rs, (20 mA) of 2 Ohms results in better than 18 dB isolation with less than 0.35 dB loss at 18 GHz.

The GaAs PIN devices allow the use of TTL buffer logic, and feature a typical switching speed of 3 nanoseconds at 18 GHz, making them useful in applications such as medium power pulsed or CW switches, duplexers and phase shifters.

Alpha Industries is represented in Australia by **Benmar International P/L, GPO Box 4048, Sydney 2001 NSW. (02)233 7566.**

Roll-your-own CCDs

Integrated Silicon Design P/L has announced Charge-Coupled Device (CCD) processing capability, now available to Australian industry.

CCDs for visible or infrared applications are catered for with the ORBIT Semiconductor's CCD process. Surface or buried-channel devices with two or three levels of polysilicon are supported.

ISD and ORBIT's staff will liaise with your design team to develop custom CMOS processes tailored to the density and complexity of your device.

Even though the larger silicon area and high density of CCDs require longer processing, ORBIT's manufacturing time may be as little as 20 working days.

For further information contact **Integrated Silicon Design Pty Ltd, PO Box 99, Rundle Mall 5000 SA. (08)223 5802.**

Facing FACTS

Fairchild's advanced CMOS family (FACT) is claimed to outperform LS, ALS and HC devices and allow higher speed operation with low quiescent and operating power.

Complementing the National Semiconductor range of logic families, FACT uses a sub-2 micron isoplanarsilicon gate CMOS process to attain speeds faster than ALS while retaining the low power and high noise immunity advantages of CMOS logic. As well, FACT features superior line driving characteristics and excellent ESD and catch-up immunity.

Direct replacement of LS and ALS devices is accomplished with TTL-type input thresholds included in the FACT family.

For more information, contact **The George Brown Group, Marketing Division, 456 Spencer St, West Melbourne 3003 Vic. (03)329 7500.**

Two new converters

Analog Devices has announced two new chips intended to provide alternative low-cost solutions for existing electronics applications.

They are the AD674A 15 μs 12-bit A/D converter and the AD736/7 rms-to-dc converters.

The AD674A is an alternative source for the 674A A/D converter (ADC), and is priced to compete with existing versions, while offering faster conversion and bus speed than other models.

Three state buffers and a maximum data access time of only 150 ns allow the AD674A to interface to most digital processors. Data can be read as one 12-bit word or as two 8- bit bytes.

Laser-trimmed thin-film resistors provide four calibrated signal input ranges. Guaranteeing a 1% maximum error, the internal buried-zener reference is trimmed to 10.00 V, drifts typically less than 15 ppm and is available for driving external loads up to 2.0 mA. All grades of the AD674A are housed in a 28-pin hermetically sealed ceramic DIP.

The AD736/7 are rms-to-dc converters intended to replace discrete designs in multimeter, audio or automatic gain-control applications.

They compute true root-mean-square ($V_{out} = \sqrt{Avg}(V_{in}^2)$), average rectified ($V_{out} = Avg\ V_{in}$), or absolute value of any ac waveform from sinewaves to complex pulse trains with crest factors up to five.

A Teraohm input impedance ($10^{12}\Omega$) and a 25 pico-amp typical input bias current simplify circuit design by eliminating the need for external buffer amplifiers – both converters connect directly to high-Z input attenuators found in most multimeters.

The AD736/7 chips are available in 8-pin miniDIP, hermetic cerDIP, or small outline package, allowing auto-insertion or surface-mount assembly techniques.

Parameters P/L are the Australian distributors of these and other Analog Devices Inc. components. They can be contacted at **PO Box 261, North Ryde 2113 NSW. (02)888 8777.**

Hot new analogue switches

Parameters claim operation to full specifications over a wide temperature range for their four channel analogue switches, the ADG211A/12A. This is in comparison to the standard +25°C figure usually quoted.

Over the 0 to +70°C range R_{on} is 175Ω maximum, while turn-on/turn-off times are less than 600 and 400 ns respectively.

Each TTL/CMOS compatible channel of the switch is independently selectable, and can handle signals over a ±15 V range, with a high breakdown value of 44 V between supplies. Leakage currents are quoted at below 500 pA typically.

Break-before-make switch action allows multiple outputs to be tied together for multiplexer applications. The switches are available in 16-pin DIP or 20-pin LCC packages.

For further information contact **Parameters P/L, PO Box 261, North Ryde 2113 NSW. (02)888 8777.**

Philips cooperating with VLSI on ASICs

Netherlands-based electronics giant, Philips, and the US-based VLSI Technology Inc. have announced an agreement in four key areas to create application-specific integrated circuits (ASICs).

The agreement covers CAD design software, foundry services, cell libraries and gate arrays.

Philips Components, with its headquarters in Eindhoven, is the leading electronic components manufacturer in Europe, and one of the largest suppliers worldwide.

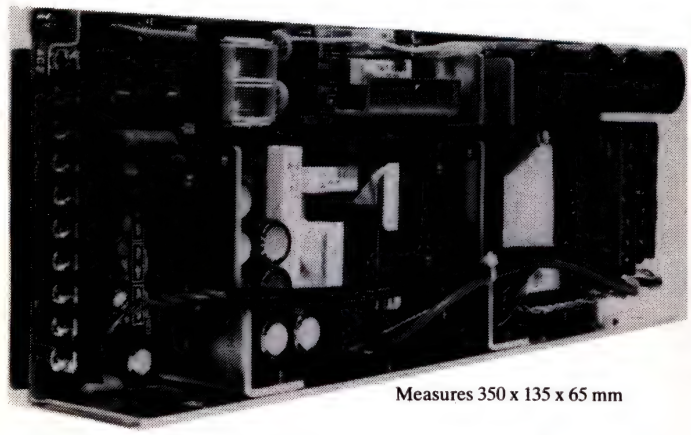
VLSI Technology, Inc. is a leading designer and manufacturer of ASICs, memories and logic products.

Philips will be making their heavy investment in worldwide production facilities available to VLSI, and VLSI will be making its substantial libraries of IC design software available to Philips.

Specifically, Philips will provide foundry services for VLSI, and will be providing an alternative-source for VLSI's VGT-series gate arrays, including the VGT100 family of 1.5 micron arrays. Philips will also be an alternative source for VLSI's next generation of one micron gate arrays.

Philips maintains that the agreement broadens their ASIC offering, allowing them to provide their customers a wide choice of manufacturing and design sources worldwide.

. . . . . PSST!



Measures 350 x 135 x 65 mm

National Matsushita Electric

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- 50 kHz Operation.
- Multiple outputs:

Output A: + 5 V, 3-15 A
Output B: + 24 V, 0.4-1.5 A*
Output C: + 12 V, 0.4-1.5 A*
Output D: –12 V, 0.4-1.5 A*
Output E: –5 V, 0-1 A

* If a lower voltage is required on outputs B, C or D, provision is made on the PCB for a TO220, 78xx series regulator to be inserted.

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Seven fundamental electronics facts

Part 1 – Kirchoff

In this, the first of a four-part series on fundamentals of electronics, the author asserts that "all electronics is founded on just seven basic experimental facts." Now that should make things much simpler!

Bryan Maher

ELECTRONICS might be described as: "An exciting way to enjoy ourselves, with a breath of physics and a smattering of chemistry, to the tune of a little mathematics".

Whatever definition grabs you, gentle reader, we will find it necessary to adopt a set of rules so that we can predict the outcome of our designs, our constructions and our actions. Surprisingly, all such rules have as their basis seven fundamental experiments. Six of these have been known since last century, the seventh since 1911.

Broadly speaking, we learn to design a radio, an amplifier or whatever, and predict its operation while the project is still on the drawing board. This is the essence of all good electronics engineering.

What shall we use for a set of rules? How will we be able to predict what will happen?

The laws of nature

We have heard of the "Laws of Physics" but in what sense are they laws? We do know for a fact that electric currents, voltages and charges will obey the laws of nature.

The truth is that we do not really know what the laws of nature are. The closest we can come is to observe experiments (ours or somebody else's), note their results and try to make up a theory which conforms to observed results.

Any theory which does not agree with *all experimental results* must be instantly scrapped or modified. Good theories will even predict, correctly, results of future new experiments. When such experiments are actually performed, if the results are as predicted the theory grows in stature.

Successful theories? If any theory thus survives many, many experimental tests over long periods – say hundreds of years – then almost everyone accepts that theory as being true and eventually it becomes referred to as a "Law".

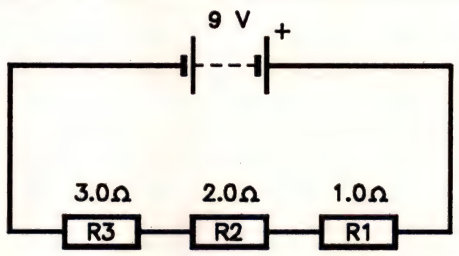


Figure 1(a). A simple circuit in which Kirchoff's Voltage Law is almost trivial. The sum of voltage gains (in the battery) equals the sum of voltage losses (in the resistors). Therefore the algebraic sum of all voltages around the loop is zero.

Thus, people speak of "Newton's Laws" – which were only a theory on "Time and Acceleration" which stood the test of many experiments for 240 years, until challenged and defeated by Albert Einstein in 1905-1915.

Upon which experiments do we base our theory of everything electrical? A vast, fascinating body of electronic and electrical theory can open its doors to us, but it rests on just *seven* fundamental experiments. Yes, just seven!

Of course, these seven experiments have been repeated countless times by many people worldwide, all results agreeing. Most of these experiments date from the last century, some as far back as 150 years, the most recent in 1911.

Why do we believe? It is simply because of this mass of corroborating experimental evidence that we believe these theories to be true – no other reason! Theories are never *proven* true, only supported by an abundance of agreeing results. But just one valid contrary experimental result will destroy any theory.

We keep that fact firmly in mind despite these theories being so well tested and believed that they are now always referred to as "Laws."

In roughly historical order let us consider the seven theories called "Laws".

The first law

KIRCHOFF'S VOLTAGE LAW

"The algebraic sum of all voltages around any closed loop is zero."

Gustav Kirchoff (Germany 1824-1887), was brave enough to speak thus and was kept busy for years defending his theory from disbelieving contemporaries. His statement is sometimes referred to as "the KVL". (The expression *algebraic sum* simply means add them up, but take positive and negative signs into account).

Figure 1a shows a very simple circuit, of a battery and three resistors. The battery generates *voltage gain*, each resistor produces a *voltage loss*. Most readers will concur that, obviously, the resistors between them "lose" all the voltage provided by the battery. Let's call battery-generated voltage "positive" and voltage used up by the resistors "negative." Say, for instance, the battery generates nine volts.

If the resistors are 1.0 Ohm, 2.0 Ohms and 3.0 Ohms respectively, the total resistance is 6.0 Ohms. The current is 1.5 amps and the resistor voltage drops are –1.5 volts, –3.0 volts and –4.5 volts respectively. ▷

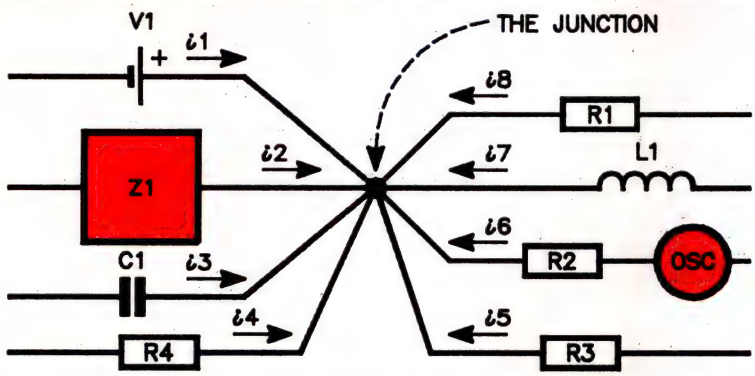


Figure 2(a). A random choice of any junction in any circuit might look like this. Kirchoff's Current Law says that the algebraic sum of all currents at that junction adds up to zero.

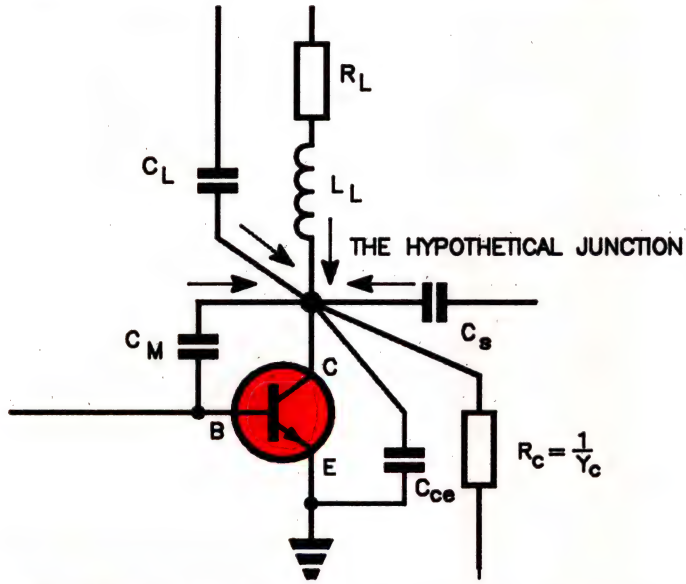


Figure 2(b). The "Junction" in the Kirchoff sense is not one of the circuit components. The junction is a hypothetical point from which all current components could be imagined to start or finish. R_{Load}, L_{Load} and C_{Load} constitute the Complex Load, C_M the Miller capacitance ($C_M = C_{bc}(1+Gain)$), C_s represents strays.

Where does it go? Certainly it is impressive to stand at the base of one of the giant radio transmitter towers in Australia where as much as one thousand amps of radio frequency current race up that huge Litz cable, as thick as your arm, to the antenna high above – and nothing appears to be coming back!

Could Herr Kirchoff perhaps be wrong? – or out of date? True, he lived long before such large radio transmitters were even thought of. Need we change his statement to suit today's world?

No, the Kirchoff statements are still as correct as ever! Consider, if you will, most ardent reader, Figures 2b and 3 and our definition of what a 'junction' is: "A junction is *not* a circuit component."

The transistor. No, that transistor collector terminal is not a "junction" in the Kirchoff sense. Figure 2b shows how we should interpret the meaning. There is some hypothetical "point" in the circuit to which we imagine all real wires and circuit board tracks heading.

To this imaginary "junction" go the load currents due to the transistor conductivity. Also to it, by a separate path, go the out-of-phase "leading" currents due to the transistor's Miller capacitance, C_m:

$C_m = C_{bc}(1+Gain)$.

And don't forget currents due to other stray capacitances C_s, the collector resistance R_c and the load complex impedance R_{Load}, L_{Load} and C_{Load}.

Phew!

KCL is up-to-date. With this interpretation, the KCL is quite correct and modern, and we can use it to solve all questions of current values and transistor gain. We can even use it to calculate the stage passband (provided the transistor used has a top frequency f_T much higher than circuit frequencies).

Now what about the antenna puzzle?

The antenna. As we feed current to the base of that whip antenna, the electrons travel up the whip and in so doing generate (transfer their energy to) an electromagnetic field which promptly radiates away, carrying that energy with it.

"Electromagnetic field" means an electric field and a magnetic field electrically in phase but physically at right angles to each other and mutually at right angles to the direction of propagation.

Radiation. The whip antenna itself is parallel to the electric field and hence the radiation propagates away in a direction at right angles to the antenna.

Call the electric field strength E, which is measured in volts per metre.

Call the magnetic field strength H, which is measured in amps per metre.

Now E can be called the equivalent of 'voltage' in a conductive circuit – and H is the immediate counterpart of 'current', i.e: real electrons, in a conductive circuit.

Therefore, the quotient E/H must have the units:

$$\frac{\text{Volts per meter}}{\text{Amps per meter}} = \frac{\text{Volts}}{\text{Amps}} = \text{Ohms Resistance}$$

Notice we have said "resistance" rather than "impedance", because the electric and magnetic fields are mutually in-phase. For the radiation field, the phase angle (∅) between electric and magnetic components is zero, i.e: cos ∅ = 1.0, or if you like, their "power factor" is unity.

Free space. Now what of the "Free Space" in which our electro-magnetic waves are travelling? There is no "free space" near the earth – because the ground, structures and masts compromise the electrical environment – but for very short wavelengths the top of a mast *approximates* free space. Anyway, we can do some calculations for the "ideal" conditions.

Recall the conditions of a tuned circuit of an inductance L, a capacitance C and resistance R, where we write:

Quality factor $Q = X_L/R$

also,

$Q = X_C/R$

therefore

$$Q^2 = \frac{X_L X_C}{R^2}$$

$$(QR)^2 = X_L X_C$$

$$QR = \sqrt{X_L X_C}$$

$$(QR)^2 = \sqrt{(2\pi fL/2\pi fC)}$$

$$QR = \sqrt{(L/C)}$$

The algebraic sum of all voltages around the loop is then:

(+9.0 volts) + (–1.5 volts) + (–3.0 volts) + (–4.5 volts) = zero !

And no-one will wish to argue with that result, except perhaps to say: "Why bother, it's trivial !!"

Perhaps. But now consider Herr Kirchoff's statement in the light of Figure 1b. Not quite so obvious, is it? Not so trivial?

Figure 1b shows any old circuit in which some loops contain "generators", a general term meaning anything which can generate voltage of some sort. Could be batteries, oscillators, flip-flop astable circuits, dc generators, ac alternators ... almost anything.

In all loops the "Law" appears true. We draw loop arrows if it pleases us to indicate loops we are considering. The Law is true for all loops, separate or joined. The rectangles in the Figure mean any arbitrary circuit component. The little boxes indicate resistances. Four loops are indicated, but more exist.

All loops? In fact you can draw quite a few loops here. The KVL says that for every loop you can draw in the circuit, the voltage algebraic sum will be zero. Yes, even if the various "generators" produce different waveforms at different frequencies, all out of phase, and some even dc.

The consensus of opinions here will be that, for this circuit, the KVL law is not a bit trivial, nor is it obvious. Yet, it is true!

Some positive, some negative. For the algebraic sum of all voltages around a loop to be zero, obviously at any one moment some voltages must be positive and some negative.

All generators cause a voltage gain (positive or negative) and resistances always cause a voltage loss. Countless experiments have shown this "Law" to be true. It has never been experimentally contradicted, so we believe it.

Useful? Lastly, what use is this Law to us? The answer is that it can be used to write a set of simultaneous voltage equations (one for each loop) which, when solved, give us the values of all currents and voltages in every part of the circuit. And that's quite some achievement!

It is common practice to assemble all those equations into a matrix for which the solutions are found using a suitable computer program. By using KVL this way we can find many answers to complex electronic circuit questions.

The second law

KIRCHOFF'S CURRENT LAW

"The algebraic sum of all currents flowing to any one junction is zero."

Again, Gustav Kirchoff was game enough to give voice to a precise, succinct summary of all his experimental results. His statement is fondly nicknamed "the KCL". Though concise, his edict is not cryptic. No. It means literally what it says.

Arrow directions. Figure 2a shows any junction in any circuit in which we have arbitrarily drawn arrows inwards to provide an assumed current direction. Clearly for the algebraic sum to be zero, some currents have to be positive and some negative at any one moment. We mark the arrows in Figure 2a without thought.

If a current turns out to be actually flowing in the arrow direction, we consider it positive. If in fact it proves to be flowing in the opposite direction, we think of it as negative.

Magnetic coupling? Do we allow magnetic coupling between components? For instance in Figure 2a, what if Z1 were a transformer primary and L1 its secondary. Would the KCL still apply?

The quick answer is – "Yes, Kirchoff's Law still applies, but allowance must be made for the transformer secondary current appearing as "reflected load current" in the primary, giving a greater value of primary current. That is, in Figure 2a part of current i2 must be added to i7.

Alternatively, we note that currents i2 and i7 in Figure 2 would have to be in some fixed ratio to each other, a ratio set by the inverse of the turns ratio, plus allowance for the magnetising current.

Stacking up current? The law simply says *"current cannot stack up or accumulate at a point junction"*. Nor can current just "get lost", or simply disappear out of the circuit for no reason – neither can current "suddenly appear" in the circuit without cause.

A junction. We note that a "junction" is *not* a circuit component – it is a place where circuit components meet.

Before we throw our collective hands in the air exclaiming "How trivial!", let us stop and consider the hidden depth of Herr Kirchoff's statement. Audio afficionados may perhaps be thinking of a circuit "junction" as the collector terminal of their favourite output transistor, arguing that: "Of course all the current flows to it, none flows away, everybody knows that!"

"How can the sum possibly add up to zero?"

Antennas too? Amateur transmitter devotees, CB radio hounds and other riders of the sky may be spoiling for a verbal fight just thinking of their antenna feed coaxial cable, with its pride-and-joy 'Antenna Current and VSWR Meter' proudly showing: "Two and a bit amps going "up the stick" to the base of the "grounded" quarter wave unloaded dipole whip antenna..."

"...and it never comes back!"

How can the algebraic sum be *nothing*?

One meticulous reader might even go further: "What about a point halfway up the whip aerial? That beautifully flexible whip pointing upwards like a swizzle stick towards the sky?"

"We know that the current flowing in the antenna is greater near the bottom 72 Ohm feedpoint than it is towards the far end. Current on the lower side of any point must be greater than current on the upper side."

"Where is any point at which the algebraic sum is zero?" ▷

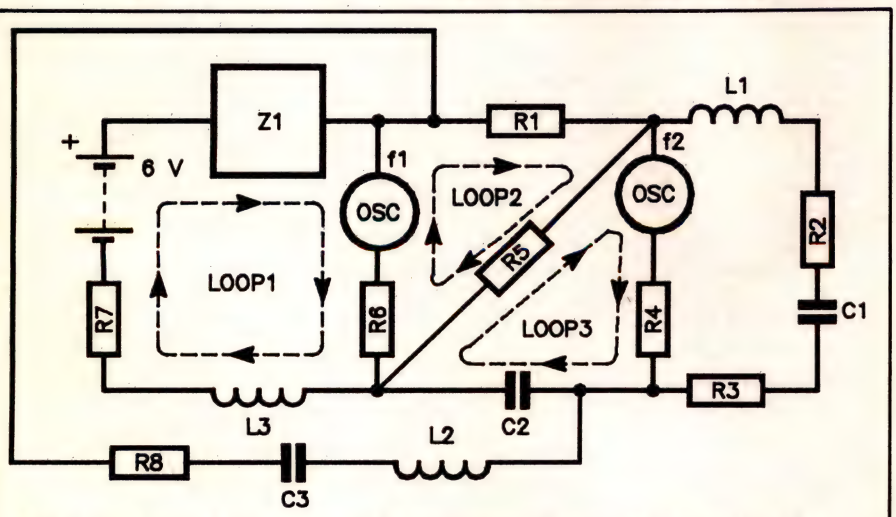


Figure 1(b). A non-trivial example of the application of Kirchoff's Voltage Law. The components may be anything, the voltage sources may be any type, generating mixed waveforms, mixed frequencies at any phase angles. Still, in any loop you like to draw, the algebraic sum of all voltages adds up to zero.

Space equivalents. Now inductance, L, in a conductive circuit is the equivalent of the magnetic permeability of free space (in Henries per metre) for electromagnetic radiation, and . . . capacitance, C, in a conductive circuit corresponds to the electric permittivity of free space (in Farads per metre) for radiation.

Therefore, for free space radiation, we have:

Space Equivalent of (QR)

$$= \sqrt{\frac{\text{permeability of free space}}{\text{permitivity of free space}}}$$

also,

Permittivity of space = $1/36\pi 10^9$ Farads/metre

and QR will be called "The Radiation Resistance of Free Space"

It is obviously a resistance measured in Ohms because Q is a dimensionless number. Thus:

Radiation resistance of Free Space

$$= \sqrt{\frac{4\pi / 10^7}{1/(36\pi 10^9)}} = 377 \text{ Ohms.}$$

All of which means that the model circuit of an antenna which we must draw to apply Herr Kirchoff's Law must include something equivalent to the radiation resistance as a path for power to leave the antenna.

Each type of antenna includes in its characteristics an impedance matching factor, a coupling or transformation ratio between the impedance looking into its feedpoint and the 377 Ohms radiation resistance of free space, (assuming ideal free space conditions).

Complex antenna matching. The radiation resistance of free space is *real*, i.e: resistive (not reactive) or, if you like, its power factor is unity.

However, unless the cable is perfectly matched to the antenna feedpoint, that feedpoint is partly reflective of power; meaning the feedpoint is reactive, and the VSWR in the cable is not unity. Or if you like, the feedpoint appears as a complex impedance. That means that the impedance matching factor between cable and antenna (and hence to free space) is, in general, a complex number.

Assuming perfect cable-to-antenna matching, the gross view is simply that of a 72 Ohm coaxial cable joined at the feed point to a "72 Ohm radiation resistance". The fitting of the KCL to this model is obvious, almost trivial, as Figure 3 shows.

Within the antenna? However, the detailed view of just what is happening within the antenna is a much more complex matter, only made simple(?) under the techniques of "Finite Element Analysis", (which we will leave to somebody else and not pursue here!).

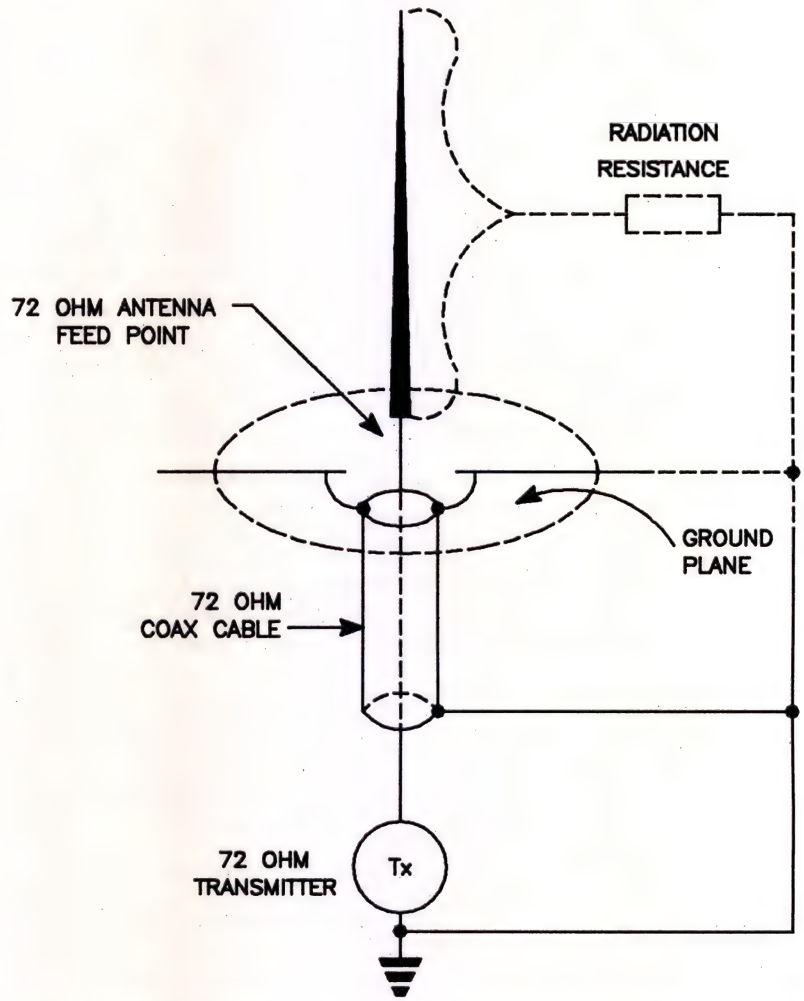


Figure 3. A "grounded" quarter wave unloaded whip antenna. A beautifully matched transmitter, 72 Ohm feeder cable and 72 ohm antenna feedpoint is almost a trivial case of Kirchoff's current law being satisfied. The design of the antenna itself matches the 72 Ohm line to the 377 Ohms Radiation Resistance of Free Space. Any investigations into current values within the antenna would lead us into the deeper maths of Finite Element Analysis – not for us here!.

Suffice to say that the KCL does in fact apply, and Finite Element Analysis computer programs written on this basis produce results which fit actual experimental results.

Measurements confirm that the value of the current varies all the way along the length of the antenna, maximum at the base decreasing as we go up, to zero current at the very top.

Changing impedance. The easy view of Kirchoff's Law in this context is to recall that the antenna is a quarter wavelength carrying standing waves, a situation which implies a transformation of impedance from 72 Ohms at the bottom feedpoint to infinity at the top. An impedance transformation implies that the antenna more or less acts as a transformer (within itself).

Considering our earlier remarks on transformer coupling between components either side of a Kirchoff junction point, we agree that Kirchoff's Law does apply at any point in the antenna, even though the currents measured at either side of that point are not the same value.

All that from those two statements of Herr Kirchoff! Definitely time for a "cuppa" and a good sleep to aid our mental recovery processes.

Next month we will look into two more of these "Laws". Bye for now.

"MANIFOLD TECHNOLOGY" PUTS ELECTRO-VOICE ABOVE THE CROWD

THE NEW MT-4 "Manifold Technology" concert sound system from Electro-Voice uses a two-point suspension flying system to minimise lobing and eliminate phasing problems inherent in conventional three- and four-point suspension systems.

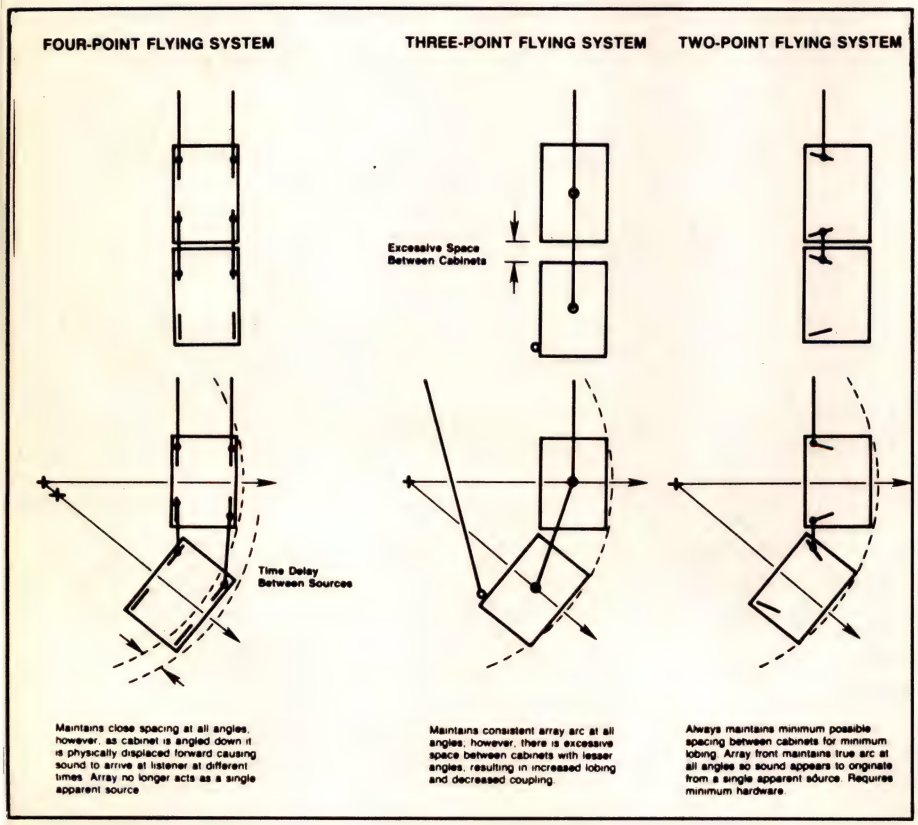
According to David Carlson, designer of the Electro-Voice MT-4 concert sound reinforcement system, there are a couple of tricks to flying a system. One is to make it convenient-to transport, to set up and tear down. The second is to build a box which lends itself to array construction.

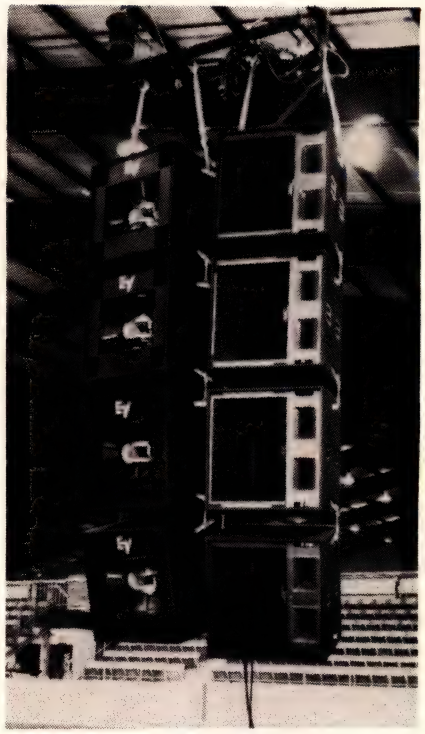
"The new flying system for the MT-4 meets-and exceeds-these design goals," Carlson stated. "In the first place, our use of Manifold Technology makes possible smaller arrays. Because there are four drivers on one horn-a format unique to the MT-4-other systems must hang more boxes to achieve the same sound pressure levels. Not only are smaller arrays easier to fly, but fewer sources in an array mean less destructive interference. With the MT-4, patterns can be controlled for better audience coverage, and polar lobing is minimised, so sound is even throughout the listening area.

"To practically apply the performance advantages, we developed a two-box system with identical modules. These same size cabinets allow perfect truck pack and simplify array construction. For even greater flexibility, we make the mid/high cabinet, the MTH-4, symmetrical top-to-bottom. Building mirror-image arrays is as simple as turning the upper box upside down. There is no need to build a second configuration of the cabinet."

In a typical rectangular venue that's no longer than it is wide, cabinets are flown in vertical stacks to achieve long throw. Here the MTH-4 configuration provides vertical line arrays of mid-bass, and mid and high frequencies for more controlled coverage. (See photo). If the venue is a theatre-in-the-round, and the situation is not one of long throw, but of wide vertical angle, the 60° × 40° MTH-4 can be rotated 90° for wide vertical coverage.

"To get the sheer SPL coverage required for high-level concert sound large loudspeaker arrays are needed. . . lots of drivers in lots of boxes aimed in the same direction," Carlson explained. "Yet, sound coming from numerous loudspeakers must arrive at any seat at the same time. To accomplish this, speakers hung in a vertical array





are curved as if mounted on the outside of a sphere. The effective source then becomes the single point at the centre of the sphere. Competitive systems effect this curvature with varying degrees of success."

With a typical **three-point flying system,** cabinets are hung one below another. Then a strap is attached to the bottom cabinet and pulled up, forcing the cabinet back and producing a curvature. However, there is little individual control over the angle of each cabinet. A second method is also common: the **four-point plying system** uses four straps between cabinets. The shorter the back straps, the greater the tilt of the bottom cabinet. But the cabinet is only angled down, not shifted back; there's no curve and therefore no single point source.

"To tilt the MT-4 cabinet, straps on two sides of the enclosure are moved back along tracks which angle towards the cabinet's edge. Moving toward the back of the track automatically puts more space between cabinets to accommodate the greater angle, but the length of the strap remains fixed. This, **two-point system**; 1. keeps space between cabinets to a minimum (a design goal which three-point systems fail to achieve), 2. allows maximum adjustment of individual cabinet angle, 3. uses minimal hardware, and 4. provides perfect curvature. "The end result," Carlson concluded, "is a flying system that's second second to none. . . flexible for a variety of venues, and quick and easy to set up and adjust."

For further information on the MT-4, contact **Electro-Voice Pty Ltd, 59 Waratah St, Kirrawee 2232 NSW. (02)521 5322.**

PA Mikes – the basics

Will Kennedy

Any sound reinforcement system is very dependent on the transducers at either end – the microphones and the speakers. There is no "universal" microphone, like there's no universal speaker. Get to know the various mike types and their characteristics, and you're a long way towards putting together a successful sound system.

Illustration: Shure's new classically-styled Model 55Sh Series II mike, for stand-mounted use. Available from Audio Engineers (02)29 6731.

IT DOESN'T MATTER whether you're looking at purely speech, or voice, reproduction or whether it's music, it's important to get, or use, a microphone for the job that will *do* the job without throwing in "surprises" or creating unpredictable problems. Conversely, given an existing sound setup, how do make the best of it with the gear on hand, and how might it be improved?

As in any field, there's no substitute for knowing and understanding the "tools" of your trade. Of the four or five basic microphone types – dynamic, ribbon, crystal, condensor and electret (you might say the last two are related – see accompanying panel), only two are widely employed in sound reinforcement, the dynamic and the condenser. It is the 'native' characteristics and advantages of these that are exploited for sound reinforcement. But that's not the whole story. We'll look at their native characteristics a little later.

It would seem at first glance, that, being so small, microphone elements would pretty well pick up sound equally from all directions. In general terms, that's true, but mikes can be made so as to impart directional characteristics that are very useful in the wide range of circumstances encountered in setting up PA systems.

Microphone directivity

Microphones are made with a variety of directional characteristics, ranging from omnidirectional to highly directional. You can, and should, use these characteristics to your advantage, or to pinpoint particular problems in given situations.

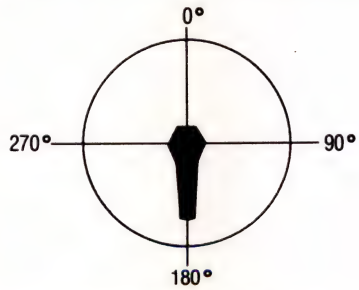
There are five general directivity "classes" applied to microphones. The shape of the graphical directional characteristics in one plane, the "polar pattern", is conveniently used to categorise these five groups:

- Omnidirectional,
- bidirectional,
- cardioid,
- hypercardioid, and
- highly directional.

Let us examine the particular characteristics of each in turn, and then we can see how they might be used in different applications.

OMNIDIRECTIONAL MICS

Omnidirectional microphones respond equally to sounds coming from all directions. Their polar pattern is circular in one plane, or spherical in three dimensions.

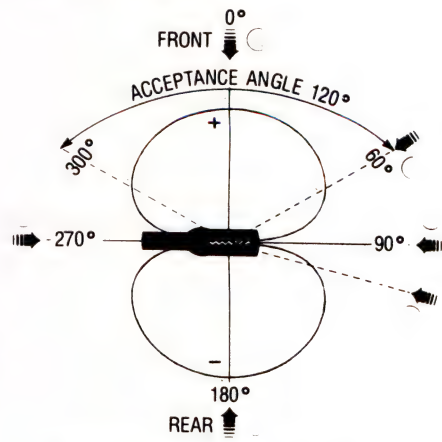


An omnidirectional mike responds equally to sounds from all directions, giving rise to a circular 'polar' pattern in one plane. In 3D, the response pattern is spherical.

They simply respond to the *magnitude* of the pressure of the air. The following types use other methods of response, and combinations of them, to produce their unique patterns.

BIDIRECTIONAL MICS

These microphones are sensitive to sound from the "front" or the "back," but pick up little or nothing from the "sides." As the sound source moves to the side of the microphone, the response progressively decreases, and the polar pattern looks like a figure of eight – a term often used to describe this type of microphone.



The bi-directional mike has a polar pattern resembling a figure 8 in one plane, rather like two spheres in 3D.

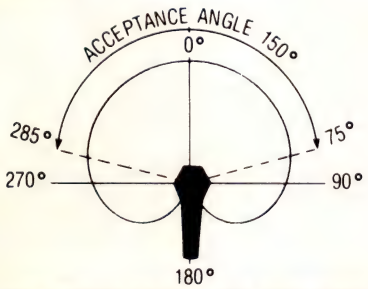
At the rear, the signal produced is equal in strength to that at the front, but of *exactly opposite phase* to it.

It should be noted that the bidirectional microphone element is not necessarily mounted so that it is aligned with the mike barrel. It is commonly oriented at 90 degrees to the axis of the mike, so that the two lobes of response extend at right angles on either side of the mike body.

Bidirectional microphones respond to differences in pressure rather than the simple magnitude of the pressure. For this reason, they are sometimes referred to as *pressure gradient* microphones.

CARDIOID MICS

As the name suggests, these microphones have a heart-shaped polar pattern. There is substantial sensitivity to sounds coming from the hemispherical area to the front of the microphone, but very little response to the rear, where there is a considerable "dip" in the response.



The cardioid pattern mike attenuates sounds from the side around to the rear. The front-on acceptance angle is typically 150 degrees.

This response pattern is obtained by combining the output of an omnidirectional (pressure magnitude) element with that of a bidirectional (pressure gradient) element. The output of the two are added at the front, but cancel each other out towards the rear (the rear lobe of the bidirectional element being exactly out of phase).

HYPERCARDIOID MICS

This is essentially a response that combines the cardioid and the bidirectional – having maximum sensitivity towards the front, and a smaller but significant response lobe to the rear.

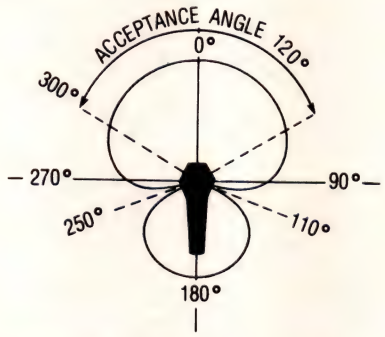
The hypercardioid pattern is produced by mixing the output of the omnidirectional and bidirectional elements in different proportions to that of the straight cardioid. In this way, a variety of hypercardioid patterns may be obtained.

HIGHLY DIRECTIONAL

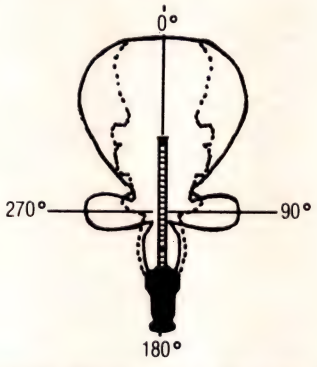
These microphones are substantially dead to sound from the sides or the rear, and exhibit high sensitivity to sounds directly in line with the axis of the mike.

They are characterised by the large size of their sound- gathering mechanism. A parabolic dish can be used to concentrate sound to a mike placed at the focus – a method often employed by naturalists recording wildlife. A more common arrangement used nowadays is to use a long tube extending forward from the main unit – the so-called "shotgun" mike so favoured by television sound recordists in the field.

Most common microphones exhibit one fixed directional response pattern, and will generally have that pattern stated prominently as part of their product name. Some mikes, however, can be changed to different polar response patterns by use of a simple switch on the mike barrel.



Hypercardioid mikes have a much narrower acceptance angle, typically 100-120 degrees, and a small response "lobe" to the rear. Note the great attenuation to the sides.



A highly direction mike ("shotgun"), will have a response pattern rather like this. Note the small rear and side lobes. The dotted line shows how the response pattern narrows at the higher audio frequencies.

The pros and cons

Just why are dynamic and condenser mikes so widely used in PA work? It is the characteristics inherent in their construction and performance that has led to their popularity.

The dynamic mike is rugged and uncomplicated. If it gets dropped, it's most likely to go right on working! It resists physical overload (too much sound pressure level) well, hence their wide use by vocalists and in miking drums.

TYPES OF MICROPHONES

A microphone is an electroacoustic transducer which responds to sound waves and delivers essentially equivalent electrical waves. Common microphones can be sorted into one of the following categories:

DYNAMIC microphones, or moving-coil microphones, are similar in principle to loudspeakers, but operating with the reverse effect. They consist of a delicate flexible diaphragm with a fine coil of wire attached. The coil is suspended in the field of a permanent magnet.

Sound pressure waves cause the diaphragm to oscillate, which in turn moves the coil relative to the magnetic field. This induces an audio-frequency current flow in the coil relative to the sound.

Dynamic mikes are simple and rugged, but lack a wide frequency response and exhibit generally poor transient response, due to the inertia of the diaphragm and coil.

RIBBON microphones are a variant of the dynamic type, which saw their heyday in the early years of radio. The output is taken from the two ends of a fine metal ribbon (typically made of corrugated aluminium alloy) suspended in the field of a permanent magnet.

Ribbon mikes exhibit good transient response, albeit with a slight "ringing" after a sharp transient. They are very fragile mechanically, although resistant to high temperature and humidity.

CONDENSER microphones, also known as electrostatic or capacitor mikes, contain a metal plate and a thin metal diaphragm set close to each other with a fine insulating spacer in between, forming a capacitor (or condensor). A polarising voltage is fed through a large value resistor to the plates of the capacitor.

Sound waves vibrate the flexible plate, in so doing altering the value of the capacitor. The output of the capacitor is then fed through an internal preamplifier to provide the output of the mike.

Condensor mikes offer good frequency and transient response characteristics. The preamp stage can, however, add a degree of noise or distortion to the signal.

ELECTRET CONDENSER microphones do not require a polarising voltage to be applied across their plates, as the dielectric material of the capacitor is made of an *electret* material, which is permanently polarised during fabrication.

The electret mike still requires a power source for its FET preamplifier, and this is usually supplied by a single replaceable cell in the body of the mike.

Electret mikes offer good frequency response with very small physical size and low cost.

CRYSTAL, or piezoelectric microphones depend for their operation on the generation of an electric charge by the deformation (by the sound pressure waves) of a crystalline piezoelectric insert.

Crystal mikes offer low – medium fidelity, and are high impedance devices more often than not associated with older, valve-operated equipment. They are mechanically very rugged.

The only major disadvantage of the dynamic mike is its lack of transient response compared to other types. The cheaper models generally lack adequate response at the bass and treble ends of the frequency response, too.

The condensor mike ('traditional' or electret) has a wide frequency response and good transient performance. The electret type is the more rugged. Condensor mikes are used where a smooth, wide frequency response is required e.g: miking a grand or upright piano.

Condensor mikes have a drawback in that they require power for their internal preamps, necessary to raise their very low output to a usable level. This may be provided by a battery within the mike body or via the signal leads – known as "phantom powering", from a source ranging from around 15 volts to 60 volts. They are somewhat prone to overload, compared with dynamic mikes.

Further, condensor mikes pack up under extremes of temperature and humidity, although modern electret types are far less prone to this problem than was the case in the past.

Ribbon mikes were once widely used, but not so now as they are comparatively fragile. However, it is generally considered they have the best transient response, but some models suffer from ringing following a sharp transient which adds a noticeable resonance to the sound.

Crystal mikes, while having the advantage of high output, exhibit uneven frequency response and some distortion and are generally relegated to "low class" applications. e.g: portable tape cassette recorders.

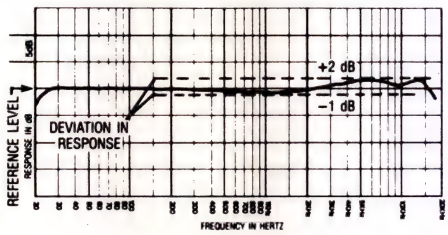
Frequency response

The frequency response of a microphone can be an important factor in its choice and application. While an "ideal" response covers the audio spectrum from 20 Hz to 20 kHz, few units approach the ideal, nor is it always desirable.

Miking wide-range instruments like a piano or pipe organ requires a smooth, wide frequency response, while using a mike with some rolloff at the higher frequencies can be used to discriminate against unwanted sources of noise, such as audience noise, air conditioning, etc. Similarly, a mike with some rolloff at the lower end will attenuate low frequency noise, such as reverberation, without affecting higher frequencies, particularly the voice.

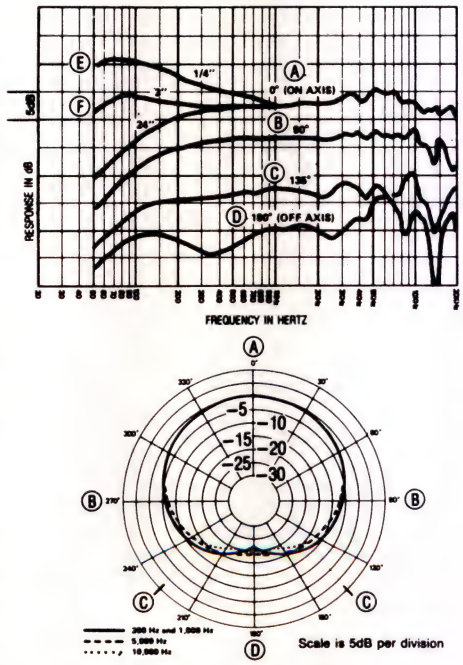
Some microphones have a "shaped" response that provides a "presence boost" in the upper mid-range region around 4-5 kHz. Such microphones are particularly used for vocal work, to "project" the upper range of the voice.

The frequency response of a microphone is affected by proximity – the bass response rises the closer you get to the mike. This effect is pronounced with cardioid response mikes, and in particular, dynamic types. It is used to great effect by singers during soft passages in order to get an "intimate" feel. Typically, the bass response rises 10-15 dB in the 50-200 Hz region when the source moves from around 600 mm away up to 6 mm.



Typical front-on frequency response of a good quality mike.

Shaped response microphones can be a boon where reverberation brings on feedback as they can provide increased gain before the onset of feedback. Some manufacturers provide switchable or variable response to take advantage of this.



Off-axis performance of an actual microphone (cardioid). This is typical of good quality mikes.

The off-axis frequency response of a microphone may not be the same as its front or on-axis response, giving rise to what is called "off-axis colouration". A good quality mike will largely maintain its polar pattern across the frequency response range, varying only at the extreme limits. But a poor microphone may change its polar response from cardioid to omni at the higher frequencies, rendering it susceptible to unwanted noise pickup.

Today's condensor mikes are light weight and more rugged than earlier models. This is the new Beyerdynamic MCE 81 from the company's new "tour series", available from Hi-Phon Distributors (02)417 7088.

Impedance

Manufacturers provide their microphones with various output impedances on one of two ranges: low – 50 to 250 Ohms, and high – 20k to 50k. Dynamic mikes are all inherently low impedance, from their construction. High impedance dynamic mikes have an in-built step-up transformer. Condensor mikes are inherently high impedance, though with an in-built preamp, the output impedance may be tailored to meet requirements.

High impedance mikes can only be used where the cable run is limited to something less than six or eight metres as the cable capacitance begins to markedly roll off the mike's high frequency response beyond that. In addition, high impedance lines are susceptible to noise pickup radiated from fluorescent lights, strobes and electric motors.

Mikes which have a very low impedance, 50-100 Ohms, are much less sensitive to electrical noise pickup, but are susceptible to induced hum from the electromagnetic fields around ac power lines and cables. Shielding doesn't help, but twisted-pair cable does. Cable lengths for very low impedance mikes are limited to about 30 metres or so as signal is lost in the inherent resistance of the cable. This doesn't affect frequency response, merely the signal-to-noise ratio.

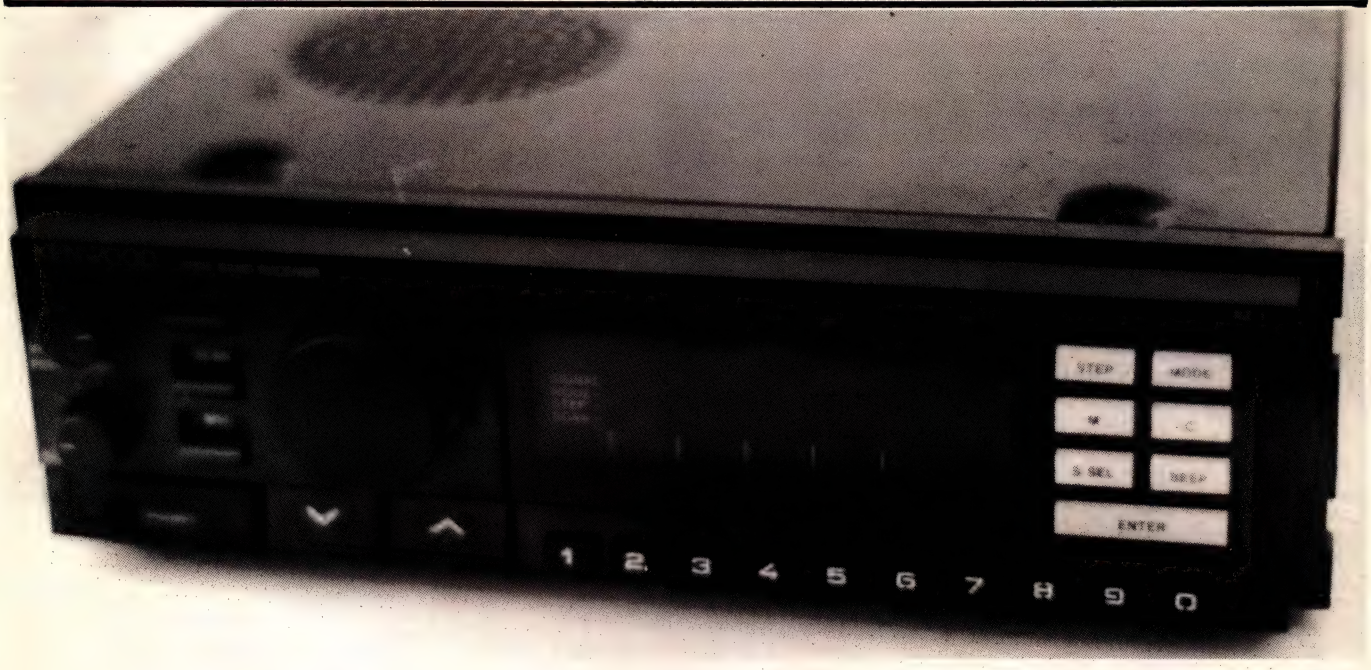
Mikes in the 150-250 Ohms impedance range minimise these two effects and require shielded, twisted-pair cable for best results. Signal losses are low and cable capacitance is not a problem, hence cable runs of 100 metres or more are possible.

Well that covers the basics, perhaps we'll tackle miking techniques in another article, another time.

We are indebted to Electro-Voice P/L for supplying material used to illustrate this feature.

3RD BIRTHDAY CONTEST No.7.

Win this scanner's delight, the Kenwood RZ-1 Wideband Receiver. Worth $1045!



The RZ-1 scanner from Kenwood provides continuous reception from 500 kHz to 905 Mhz. The AM and FM broadcast bands are covered in their entirety. Designed to be installed in a vehicle, but equally "at home" in a base station installation, the RZ-1 operates on 12 Vdc and can accept either a Motorola-style antenna plug or the PL-259 style familiar to mobile transceiver users.

Boasting 100 memory channels, the RZ-1 stores not just the frequency, but also the mode of the station as well as an optional seven-character alphanumeric identifier. Unlike many other scanners, the RZ-1 is ideally suited to replacing a standard car radio, as it duplicates all the conventional broadcast band functions as well as providing a wealth of features for MF, HF, VHF and UHF reception. All of these features are available in a remarkably compact package, measuring only 180 x 50 x 176 mm.

You can use it mobile, or use it at home! *And* we'll throw in a "Squeeky Clean" LF-4 Mains Filter from local manufacturer K.C.C., so you can pull in those signals free from mains-borne interference.

The Kenwood RZ-1 was reviewed in our June 1988 issue.

Prize kindly donated by Kenwood Australia.

1) Who is the Communications Products Manager for Kenwood Electronics Australia?

. . . . . .

2) Would you or would you not be able to pick up the Kingsford Smith weather broadcast on the Kenwood RZ-1 receiver?

. . . . . .

3) In what Sydney suburb is filter manufacturer K.C.C. located?

. . . . . .

Tell us, in 25 words or less, what features of the Kenwood RZ-1 receiver best suit your needs.

I have read the rules of the contest and agree to abide by their conditions.

Signature: _____

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Novices get 2 MHz of two metres

Wednesday June the 1st saw the arrival of Novice licence holders on two metres, following almost 12 months of controversy over the issue which surfaced at the 1987 Federal Convention of the Wireless Institute of Australia.

After much discussion the Department of Transport and Communications decided to grant Australian Novices operating privileges on the top half of two metres (146-148 MHz), FM only and 10 watts maximum power output.

The new Novice privileges were first announced on the WIA state broadcasts some three weeks beforehand.

Things were quiet in the Sydney area on the first morning of operation. Quite a few Novices were on the band, but nothing like the much-heralded rush.

An oft-repeated rumour on air that day suggested that two metre FM rigs could not be had for love nor money from the local dealers. (No rumour – later confirmed when we phoned the major dealers – Ed.)

In order to welcome the new operators to the band, and to help make their transition to VHF as smooth as possible, we are presenting a series of articles on FM operation on two metres, as a "primer". The first part, on some basic VHF technical and operating requirements, is presented elsewhere in this issue.

The Victorian Division of the WIA had a two-page printed information sheet, detailing operating practices and Victorian repeater and simplex channel frequencies, available two weeks before June 1. If nothing else, VK3 are quick on their feet!

High hopes for new antenna system

Radio Frequency Systems (RFS) P/L are hoping that their Australian-designed lightweight HF antenna system will win military and civilian orders, both here and overseas.

Developed for use with the Australian Army's modern digital HF tactical radio system (code named RAVEN), the antenna is very light and can be deployed by hanging it from a tree if necessary.

RFS has the sole contract to supply Plessey, who are manufacturing the radios for the RAVEN project. High volume export and local sales for the antenna are expected, particularly for use in remote areas.

RFS are committed to expanding and continually improving its range of HF antennas through its computer-aided design facilities at its test site at Kilsyth, near Melbourne. They say that HF radio transmissions will continue to be required no matter how extensive the satellite networks become, owing to the economy and efficiency of HF.

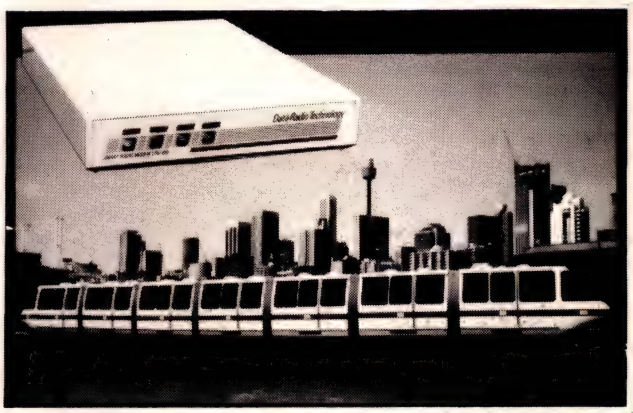
Universal coaxial adapters

Associated Calibration Laboratories P/L are offering a 30-piece universal coaxial termination adapter kit, the Unidapt kit, to technicians and engineers.

Adapters for UHF, N type, BNC and other connectors in both male and female are supplied, and can be configured as adapters from any one standard to any other, using the universal adapter supplied.

All Unidapt sections are made of silver plated machined brass with a gold plated phosphor-bronze centre pin anchored in a teflon dielectric.

The kit comes in a padded, soft, zippered carrying case, and is priced at $125 plus sales tax. ACL can be contacted at **27 Rosella St, East Doncaster 3109 Vic. (03)842 8822.**



AUSSIE RADIO MODEMS FOR MONORAIL

Sydney's recently commissioned Darling Harbour monorail is unique in many respects, not the least being the fact that it is Australia's only automated passenger train system.

Unlike Brisbane's Expo monorail, which requires the presence of a driver on each train, the Sydney vehicle is capable of complete automation – all control being exercised from a central operations centre.

And how is this control exercised?

Two Microvac II computers, running GEC developed software, monitor and control all functions on the train, including door, light and power circuits, ensuring collisions do not occur. Redundancy at all levels maintains a healthy safety margin.

Error-free data communication to and from the trains is provided by dual redundant Smart Radio Modems in conjunction with an AWA UHF FM radio system. The radio modems are the standard Data Radio Technology model CPU-100, designed and manufactured by GFS Electronics in Mitcham, Victoria.

Running specially developed software, the CPU-100s provide the system with a 1200 baud error-free data transfer capability using the full duplex radio link. They also handle the data path's networking through the use of special internal addressing techniques.

A spokesman for GFS Electronics claims that the CPU-100, with its normal BECSP (Block Exchange Compelled Sequence) software, offers a potential radio data communications user many advantages over the X.25 based modems that are imported from overseas and marketed here in Australia.

A significant feature of the CPU-100 is its high error corrected data throughput for a given link speed when compared to the X.25-based radio modems, which apparently require a much larger packet or block overhead.

CPU-100s have now gone into installations all over the world, including the Philippines, Singapore, Hong Kong and Papua New Guinea.

For more information on the CPU-100, or any other GFS radio modem products, contact **GFS Electronics, 17 McKeon Road, Mitcham 3132 Vic. (03)873 3777.**

Novices! Welcome to two metres

– a primer, Part 1

On June 1st Australian amateur radio novice licence holders were granted FM operating privileges on the top half of two metres (146 – 148 MHz). This represents more than just a simple band-change, so over the next few months we present a short series of articles to help you get going on the most popular VHF band.

Roger Harrison VK2ZTB and Jeff Ralph VK2KCD

OPERATION ON VHF FM is a world apart from the HF SSB that Australian Novices are used to. Ten watts of FM RF might sound a bit limited to the ardent HF DXer, but the mode offers significant benefits *when used as it is intended* by stations that are installed and operated correctly.

Silence is golden

FM on VHF is not intended to be an avenue for the pursuit of DX. It is unashamedly a "local" mode, but the practical definition of "local" may surprise you. DX contacts certainly happen – and on a regular basis, with distances ranging from across the state to across the continent!, as evidenced by Eric Jamison's *VHF/UHF – an Expanding World* column in the WIA's journal, *Amateur Radio*.

FM is inherently a *quiet* mode – meaning that noise caused by thunderstorms, ignition systems (or other man-made electrical interference), can be very largely eliminated. This interference is amplitude modulated (AM) in nature, and thus can be "chopped off" by the limiter circuits in the FM receiver with little or no loss of fidelity. The same interference can obliterate an AM signal, as any AM broadcast band DXers will know well.

Narrow band FM, such as we use, is not inherently higher quality than AM (in terms of frequency response), but the absence of noise on the signal gives that effect. The result is that FM contacts in all but marginal conditions have a "telephone" quality – consistent, low noise and easy to copy.

Selection of frequency is by channels, rather than the infinitely adjustable VFO found on HF SSB rigs. There is no advantage to be gained from having control *that* precise in this section of the two metre band. It is an unnecessary complication – more likely than not to cause off-frequency transmissions. The 146-148 MHz segment of two metres has been "channelised" for convenience, and you'll see why shortly.

What's 2m FM good for?

All of the above dictates that two metres FM is an ideal choice for mobile operation. Range is of the right order for local communications, quality is good for easy comprehension while mobile, and fine tuning of the frequency is not required. There are other advantages, too.

A great deal of the popularity of two metres is due to the provision of repeaters on the band. These are essentially "signal boosting" stations, which receive a two metre FM signal on a particular designated channel and simultaneously retransmit it on another channel 600 kHz removed from the input.

Repeaters are established primarily to extend the communication range of mobile stations. It is assumed that fixed stations have the resources to erect suitable high gain directional antennas when they wish to communicate between themselves, but in practice fixed stations are welcome on repeaters, and use them regularly, particularly "out-of-towners". Mobile users are in the majority at most times, however.

Repeaters are nearly always located at very favourable sites – mountain-tops, areas otherwise higher above-sea-level than the surrounding district, or even the tops of inner-city skyscrapers.

The altitude of repeater sites is the main reason for their effectiveness, since VHF communication is more typically line-of-sight than HF. Repeater output power is not high, often 25 watts, but the good location combined with their efficient antenna systems provide remarkable signal strength and quality over a considerable range.

Handheld transceivers are very popular on two metres, the repeater network being the biggest boon to their use. This is the Icom IC-μ2A.

Repeater antennas are typically multi-element vertical colinear arrays, providing useful gain whilst still retaining an omnidirectional pattern. This apparent contradiction in terms means simply that the antennas produce substantial, useful lobes at low angles of

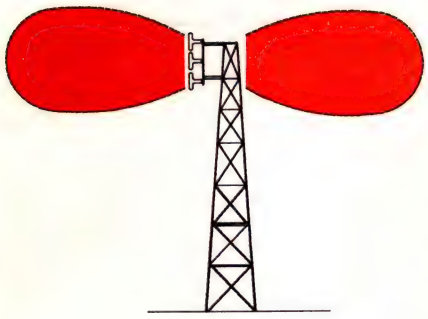


Figure 1. Typical (well, "idealised") vertical radiation pattern for a VHF FM repeater. Care is taken to achieve a low angle of radiation.

radiation, as depicted in Figure 1.

The gain provided by these antennas produce an effective radiated power (erp) typically around 100 watts, and in some cases as high as 400 watts. More importantly, however, it makes the repeater more sensitive to incoming signals.

Antennas

Polarisation of two metre FM signals is exclusively vertical (now watch someone come along and say he uses horizontal only!). Mobile antennas are vertical for obvious practical reasons, and repeaters match that polarisation to optimise their effectiveness with mobile stations.

Horizontal may well be the rule for DX work below 146 MHz, but it is certainly unusual in the FM region. Whether this situation changes when lots of experimentally-inclined operators start up in the sub-band remains to be seen.

Losses of up to 20 dB are quoted when operating at cross-polarisation to another station. Moral – use vertical unless you are establishing regular skeds with other horizontally-inclined comrades.

Antennas for two metres are a delight to construct and install, especially if your only experience is with HF arrays. Sure, a little more care must be taken with dimensions and feedlines (more on them later), but seven-element beams are featherweight and simple to install – compared to *any* HF beam! I loved my cubical quad for 10 and 15 metres, but it sure dominated my roofline. (What's your Hills Hoist doing on the roof, and why is it sideways?) The two metre array, on the other hand, is just another "TV" antenna.

The cost of materials for two metre antennas is peanuts, especially when compared to the price of a commercial VHF FM transceiver. The feedline to the antenna, especially at a fixed (not mobile) installation, does tend to offset some of this price advantage, however.

Feedlines and terminators

Coaxial cables of any type cause more loss at higher frequencies than they do at comparatively low frequencies. Whilst RG58 (50Ω) or even TV-type RG59 (75Ω) works fine at HF, the losses on two metres render them impractical for all but the shortest runs. Table 1 shows some common types of coax cables, and the losses associated with them at various frequencies.

		Loss per 30 m (100 ft) length in dB.			
Cable	Ω	80m	15m	10 m	2m
RG58/A-AU	53	0.68	1.9	2.2	5.7
RG58 foam	50	0.52	1.4	1.7	4.1
RG59/A-AU	73	0.64	1.6	1.8	4.2
RG59 foam	75	0.48	1.2	1.4	3.4
RG8/A-AU*	52	0.30	0.93	0.98	2.5
RG8 foam	50	0.27	0.76	0.90	2.2
RG11/A-AU	75	0.38	0.98	1.15	2.8

Table 1. Attenuation of common coaxial cables. (*Now more commonly available as RG213.)

As you can see, losses that were small, even insignificant at HF can become quite objectionable at VHF. An ideal coax cable would have an air dielectric, and this type *is* available. The inner conductor is separated from the outer by ring-type "washers" or spacers, so the dielectric is indeed air for the majority of the length of the cable. It is a very efficient cable (low loss), but is expensive and very inflexible, making installation difficult. A foam dielectric cable makes a convenient compromise between low-loss and convenience of use.

For mobile use, RG58 with foam dielectric is the best choice, but scarce. Your next best choice would be one of the foam dielectric 6.3 mm diameter "TV" cables such as RG59 or Hills DSC 3.2. The slightly higher SWR of the 75 Ohm cable is little disadvantage here. For runs of a few metres, RG58 is quite serviceable, but avoid "CB" coax – it makes a good "dummy" load, being quite lossy.

Whatever you use, keep the cable as short as practical, and pay particular attention to the terminations. For fixed installations, where cable runs are bound to be more than the few metres needed in the car, use the best cable you can afford. If you string up your beaut new beam or Slim Jim on a long length of ordinary 6.3 mm TV coax, you'll probably be left wondering why the band has gone so quiet all of a sudden!

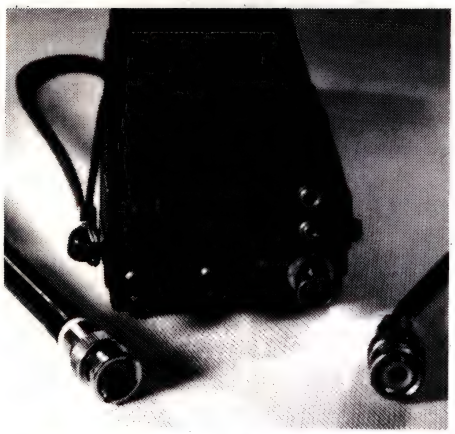
"Commercial Version" Belden RG213 (type YR22385) is stocked by Dick Smith Electronics stores. It is a good quality cable for reasonable cost. Better still is the Belden 9913, which is a foam dielectric type RG213, at about twice the cost. It has about half the loss per 30m at 146 MHz as RG213 and is available from Acme Electronics, 205 Middleborough Rd, Box Hill 3128 Vic. (03)890 0900.

Care must be taken with both the choice and fitting of the terminations on the coax. The choice of fitting will be largely determined by that which is available on the transceiver. PL-259s are the most common, whilst BNC connectors are gaining in popularity because of their slightly lower loss and quick-disconnect mechanism. Some amateurs do change their PL-259s for BNCs, but at this stage it is probably better practice to stay with whatever is on the rig. We'll get into the details of connectors next month.

Operating considerations

When first confronted with *two whole megahertz* of spectrum space on two metres, the temptation may be to think that there is almost *unlimited* space to operate on – especially to the user who ▷

The Icom IC-275A is a full-featured, all-mode two metre transceiver for the better-equipped base station. RF output power can be easily adjusted to Novice levels with a front panel control.



The BNC connector is widely used on handheld 2m transceivers, like this Icom IC-2e.

The FT-290R uses PL-259 connectors.

is familiar with 80 metres at night time.

In fact there *is* plenty of room for everyone, but it is far from a free-for-all. The top half of two metres is governed by a *band plan* which divides the total space into segments, and some spot frequencies, which are allocated for specific purposes. While the band plan, which is shown diagrammatically in Figure 2, is a "gentleman's (person's?) agreement", not enforceable by DOC regulation, *it is in every amateur's interest to observe it.* Remember that operation is channelised, not VFO.

There are two modes of operation on VHF FM – simplex and duplex.

Simplex means that transmission and reception is on the same channel. The signals are transmitted directly from station-to-station in the same manner as regular HF SSB contacts. These contacts are made in the two simplex sub-bands as shown in Figure 2. Certainly there is room for more channels than the 17 indicated at 25 kHz spacing, but there is rarely need for more – yet.

The specific use assigned to the simplex frequencies is determined for the benefit of all amateurs – just as driving on the left side of the road is in our best interests, and would still be even if it weren't required by law. There is no legal basis for these allocations, but there is a very strong logical one.

Usual conventions for simplex use of frequencies apply – namely, that channels should be checked for vacancy before they are occupied. No-one "owns" amateur channels – we are all just "borrowing" them, but current use of a channel should be respected.

The *duplex* mode is used for repeater operation. The transmitting station's signal is received by the repeater and simultaneously retransmitted 600 kHz above or below (depending on which sub-band the repeater is in) that frequency. The other stations listen to the transmission on the *output frequency* of the repeater, *not* the frequency on which the originating station is transmitting. When the user stops transmitting on the repeater's input, the transceiver switches back automatically to the repeater output frequency, so that the next contact made through the repeater can be heard.

In order to operate on, for example, repeater channel 7000 (channel numbers are simply the last four digits of the

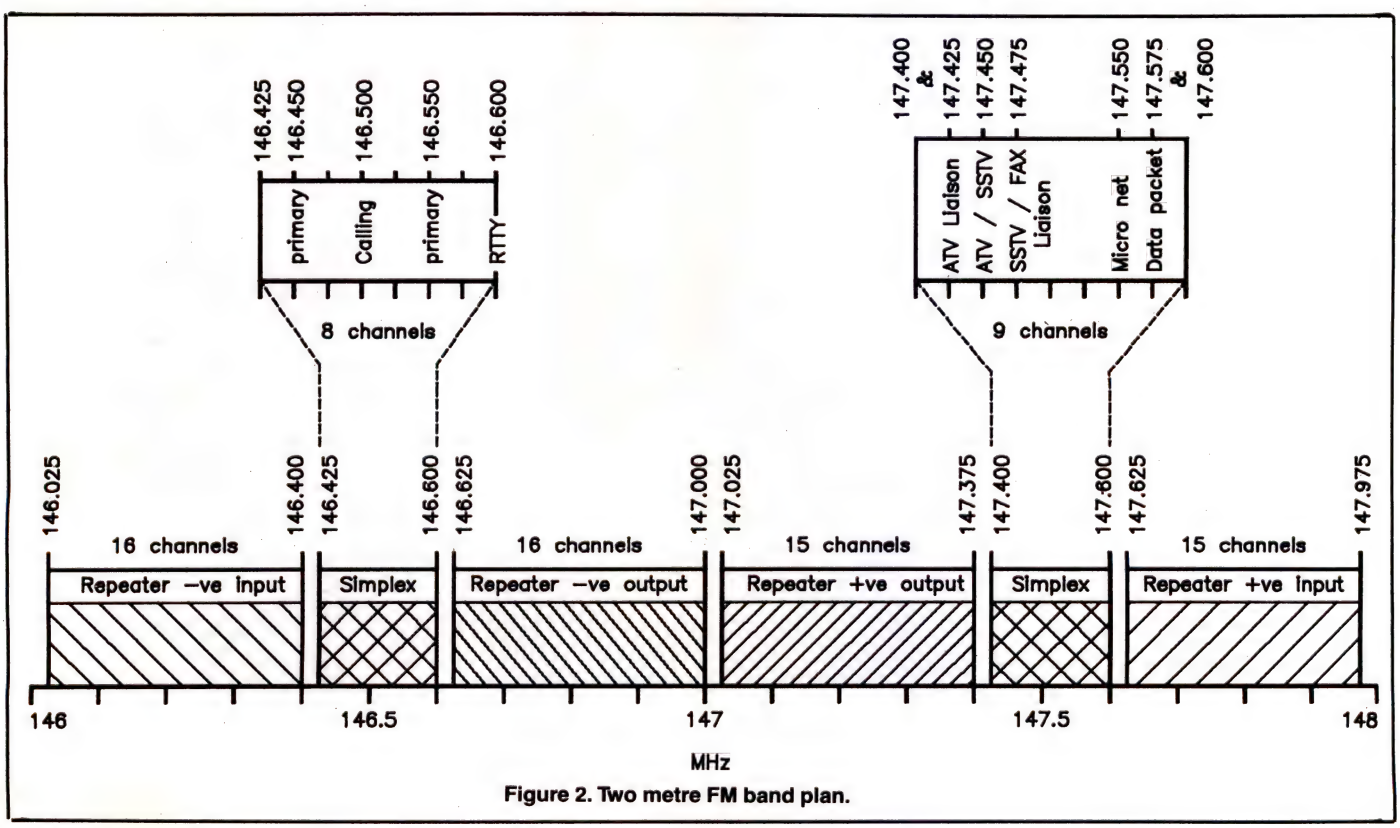
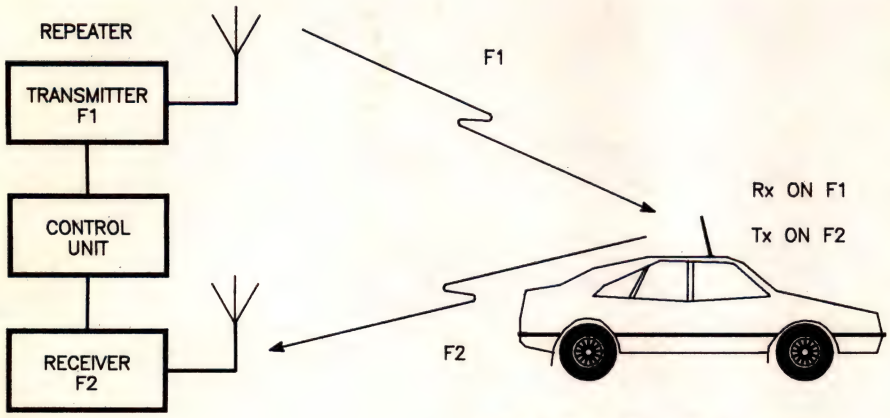


Figure 2. Two metre FM band plan.



The "duplex", two channel, repeater system.

frequency in kHz) you select that frequency (147.000 MHz) and "DUPLEX MINUS" mode. When you press the mike button, the transceiver switches automatically down 600 kHz to 146.400 MHz, the "input" of the repeater.

When you release the mike button, you will hear the quiet "tail" of the transmission. The repeater does not stop transmitting the instant the received signal stops, but continues on for a few seconds. This is to prevent erratic operation when signals down around the threshold of the repeater are being received. The effect of this is that you hear a quiet pause followed by a "kerchunk" when an over is completed.

It is good practice to allow the repeater to stop transmitting before starting your own over for two reasons:

1) repeaters will "time-out" if made to transmit continuously for more than a fixed time, usually around three minutes, but sometimes as short as one minute; and

2) it is good manners to allow a pause for other users to make a call on the repeater in between your overs.

You should be careful not to transmit on the wrong frequency. Operating simplex on a repeater output channel is definitely frowned on, as only stations in your immediate area will hear your signal. Likewise, operating simplex on the repeater input channel is not recommended, as you will probably not hear responses made to you over the repeater – or you may be be "squashing" someone else's legitimate repeater signal, without even realising it! And operating "inverse" – transmitting on the repeater output and listening on the repeater input – is twice as bad!.

CQ calls are not appropriate on repeaters. The purpose of CQs on HF is to establish your presence on a particular frequency, and to give a roaming station time to hear your signal, tune the transmitter, swing the beam around, etc. On a repeater, you will be heard with crystal clarity the instant you transmit, so it is only necessary to announce that you are on the frequency, and waiting for a contact. By all means repeat the announcement after ten seconds or so, in case it was lost in traffic or road noise, but *never* make prolonged CQ calls on a repeater.

Listen for a while to find out how the old hands establish contact. There is no need to announce your full callsign at the end of each over – particularly during a quick conversation. Once at the start of a session, and again when you sign off, but otherwise only often enough to enable casual listeners to determine who is on the channel and to keep within regulatory requirements. If you are in easy simplex range of the person you are in contact with, it is good manners to vacate the repeater, and use a simplex channel instead.

Sad to say, it is most likely that repeater users will eventually encounter antisocial operation. There is one, and only one, effective way of dealing with this behaviour, and that is to *ignore* it. Engaging in arguments, reprimanding the culprits or abusing them back will only inflame the situation. Keep quiet – even turn off – *but don't acknowledge their existence*. Remember that for every station you hear transmitting, there are probably a few just listening, and making judgements about the character of the transmitting participants. Your face could be quite red at the next club meeting!

Repeaters are provided as a free public service by amateur radio club members. Access is unrestricted, unlike some overseas operations where a special encoded signal must be transmitted to access a repeater. It would be a shame if repeaters were closed down simply because the enthusiastic individuals operating them lost interest.

The WIA Australian Amateur Radio Call Book contains a comprehensive listing of two metre repeaters, with their frequency, power, range, location and other useful information listed.

• to page 114. ▷

VOICE REPEATER GUIDELINES

This summary of operating conventions on two metres FM comes from the VK3 Division of the Wireless Institute of Australia (WIA). It is probably timely for all repeater users to brush up on their operating technique now that there are to be so many newcomers on the air.

CONVENTIONS:

- Each transmission should not exceed two minutes. Repeaters have timers to limit transmission length.
- Before replying, let the repeater "drop out" and wait at least three seconds before transmitting. This allows others immediate access.
- Do not reset the timer to extend your own transmission time.
- Keep contacts brief and to the point. If you have nothing to say, don't say it! Limit your group QSO to a maximum of ten minutes.
- Avoid over-use of callsigns. They are required at the start and end of a contact, and at least once every ten minutes – but callsigns can be dropped from the start and end of transmission during a contact. Phonetics are also over-used on repeaters, particularly in callsigns.
- To gain access to a repeater which is being used by others, simply announce your callsign during the pause between overs.
- If using a repeater and another station announces its callsign during the pause, let the station go ahead immediately. He or she may have an urgent message.
- Do not transmit on repeater output frequencies. Use reverse facilities only to observe another station's input signal strength. If satisfactory, then QSY to a simplex channel.
- Ignore annoying transmissions. Do not respond or comment on a transmission not identified by callsign.
- There is no need to call CQ on repeaters. Just announce your callsign and say you are listening on the frequency.
- The use of repeaters for liaison to establish contact on another band is permissable, but cross-band contacts using a repeater are not encouraged. Where cross-band contacts are made all frequencies must be announced by all parties.
- Priority must be given to normal repeater usage.

COURTESY:

Be courteous and unselfish at all times, and always be aware of the needs of other people who have an equal right to use the repeater.

If you hear someone new to repeater operation, assist and educate them in a courteous manner.

Remember that others, including new or potential radio amateurs, monitor repeaters – the image of amateur radio is important.

An "active" antenna matcher for shortwave reception

Part 1

Roger Harrison

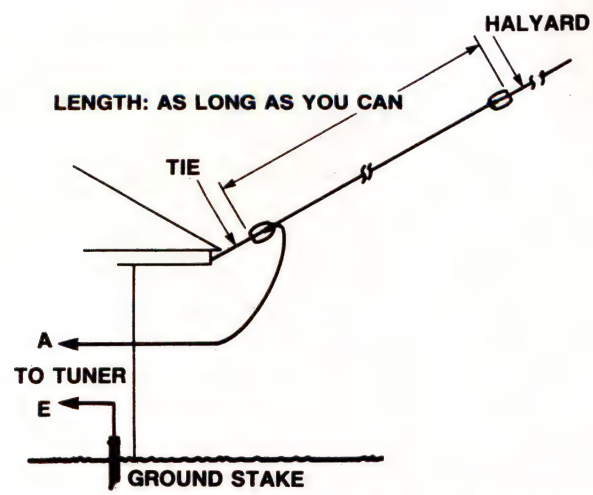
Unless you're fortunate enough to have an "antenna farm" of 'ideal' antennas to suit every band or frequency of interest to you, whatever antenna you use for general listening around the shortwave bands will be something of a compromise. This project beats the deficiencies of that compromise and will provide a remarkable improvement in reception.

FOR LISTENING around the shortwave bands up to 30 MHz, many enthusiasts use a "random" length or wire strung up in some convenient fashion as an antenna. Being cheap, simple to install and use, this arrangement has obvious advantages. Its big disadvantage is that, only at a few (probably unpredictable) frequencies will the impedance of the antenna 'match' the input impedance of the receiver and thus obtain optimum efficiency.

In some situations, e.g: with "short" whip antennas or dipoles such as our AEM3106 *(March '88)*, the antenna will probably *never* match the receiver's input impedance.

While modern shortwave receivers are very sensitive and will "pull-in" signals with just a few metres of wire on the antenna terminal, there's no substitute for a well-matched antenna. To accomplish this, a "matching" circuit or "tuner" is employed to "transform" the antenna's unknown impedance to that of the receiver's input impedance, which is usually 50 Ohms.

Where electrically "short" (in terms of wavelength) antennas are used, as in the examples given in the paragraph before last, their signal "pickup ability" is substantially less than for antennas which are half a wavelength or longer at the frequency or frequencies of interest. Hence, a little RF amplification could be used to lift performance.



The classic "random" wire antenna. To make the best of it, an antenna tuner is mandatory.

The tuner-amplifier

This project comprises a tuneable, or variable, matching section, followed by an RF amplifier, as shown in the accompanying block diagram.

The tuner section needs to be versatile so that it can cope with a wide variety of input requirements and impedances. Inputs may be:

- balanced (two-wire), or
- unbalanced (single wire or coaxial cable).

The balanced input can be handled with a balanced-to-unbalanced transformer, or "balun". Balanced input, unbalanced output tuners are really a "special case", so what we require is a tuner with unbalanced, or "single ended", input and output connections.

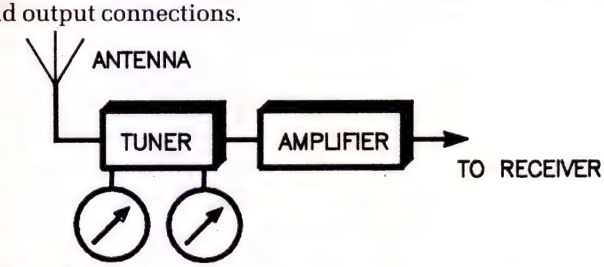


Figure 1. To cope with the unpredictably wide range of antenna impedances and sizes (and thus pickup ability), a tuner or matching unit is followed by an RF amplifier in this project.

A whole variety of matching/tuning circuits have been devised over the years, but a great deal of "collective" experience has distilled the choices down to about three:

- the "L" matcher,
- the "Pi" matcher, and
- the "SPC", or serial-parallel capacitance, matcher.

Each has peculiar advantages and disadvantages, so let's have a look-see at what they are and their appropriate applications.

The L matcher

From the circuit shown in Figure 2, you can see why it's been dubbed an "L" matcher – the inductor and capacitor form the letter L, albeit tipped over backwards! Both the inductor and capacitor are variable, to afford impedance matching over as wide a range as possible.

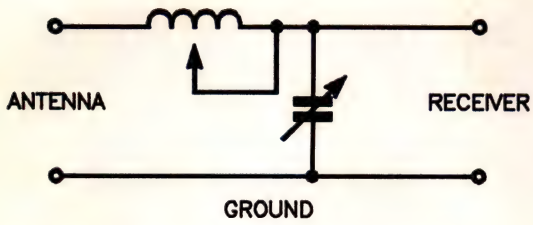


Figure 2. The "L" matcher – ideal for short antennas.

This circuit is useful for antennas which exhibit a substantially capacitive impedance – which is typical of "short" antennas. Short antennas are less than a quarter wave long at the frequency of interest or the highest frequency you wish to use. They have a very low "radiation resistance" which presents special matching difficulties. The L network is ideal for this as it will "transform" a low resistance/high capacitance to a low/medium impedance. However, where this is not the case, a different matching network, or circuit, must be employed.

The pi matcher

This would have to be just about the most universally used matching network. Figure 3 shows where it got its name – the circuit resembles the Greek letter pi. All three components here are made variable, the inductor and the two capacitors.

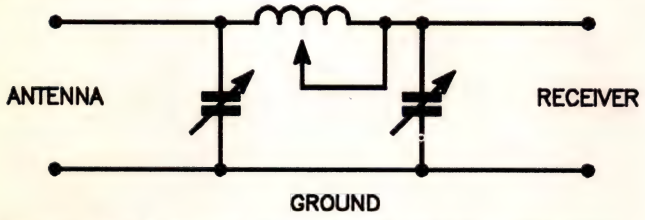


Figure 3. The "pi" tuner matches a wide range of impedances.

The pi network is inherently more flexible than the L network and will match a very wide range of impedances. But, with three variable controls, you may need some patience to adjust it for optimum performance!

The SPC matcher

The "serial parallel capacitance" – hence, "SPC" – matching network, shown in Figure 4, has gained prominence in recent years. Like the pi matcher, it has three variable controls, but note that the antenna-side variable capacitors are *ganged*.

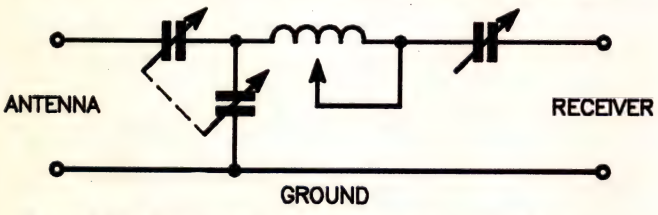


Figure 4. The SPC tuner is very versatile but difficult to implement.

This network will provide matching over a very broad range of impedances, but has the drawback that, with most capacitors – and especially dual-gang types – their stator plates are connected to the frame, and none of the capacitors can have the frame connected to common (or ground). Secondly, the dual-gang capacitor really needs to have sections of equal capacitance and such capacitors are quite rare these days. And mechanically coupling two single-gang variable capacitors is impractical, with the types that are available.

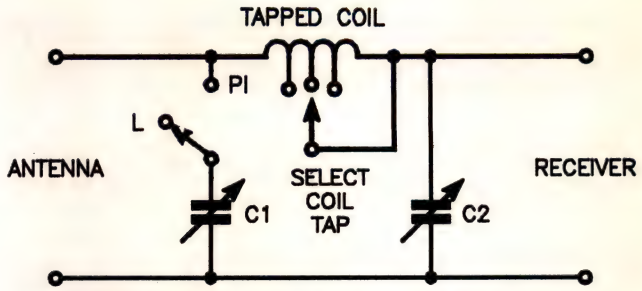
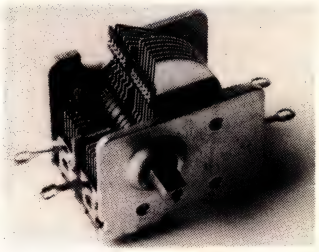


Figure 5. With the addition of a single switch, the pi matcher can be configured as an L matcher, too. This is the circuit we finally settled on.

A flexible matcher

If you look at Figures 2 and 3, the similarities between the L network and the pi network are immediately apparent – the pi has one more "element", a capacitor, than the L network.



Suitable tuning gangs are, fortunately, readily available. This one, used in our prototype, is stocked by Jaycar, cat. no. RV-5740. All Electronic Components also stock similar units.

By simply arranging to switch the antenna- side capacitor in and out of circuit, we can have the advantages of both the pi and the L network.

The circuit of Figure 5 shows how it's done. Here, C1 is switched in to make a pi matcher, or out to make an L matcher. Variable capacitors C1 and C2 can be single-gang or dual-gang capacitors, but C1 and C2 can't be ganged together. Dual-gang "broadcast" type variable capacitors are available, in a variety of styles, and are ideal for the job. However, each gang has different capacitances, one having a lower maximum capacitance as it's used to tune the local oscillator while the other tunes the RF input to the mixer in a superhet receiver. One type, sold by Jaycar, has one gang with a 250 pF maximum capacitance, with the other (the 'oscillator section') being 120 pF maximum.

In this application, it would be best to use the two sections paralleled for C1, to provide a greater capacitance "swing", or variation. This is because the greatest impedance variation will be encountered at the antenna, or input side. For C2 here, a switch can be arranged to connect one gang only in circuit, or to parallel both gangs to provide more maximum capacitance where it may be required.

While an infinitely variable inductor is ideal, they're impractically difficult to obtain. If this is to be a practical project, then we can't use impractical components!
Hence, a tapped inductor with a switch to select differing amounts of inductance is shown.

Next month, we'll get onto the "active" part, the amplifier stage, and get stuck into the construction.

Call to restore our national frequency and time standard transmission service, station VNG

Dr. Marion Leiba

Our national frequency and time signal service, VNG, was closed down on 1 October 1987 for financial reasons. Dr Marion Leiba, the secretary of the VNG Users' Consortium, gives us a background to the widely-used service, and presents cogent arguments for its re-establishment.

A RELIABLE, CONVENIENT and correct source of time is required by people in all walks of life, from a jeweller rating wrist watches as part of his customer service, through amateur astronomers, radio and TV operators and sailors to professional astronomers, seismologists, surveyors and navigators for whom accurate time is essential in finding stars, establishing positions, determining locations of earthquakes, detecting nuclear explosions and many other activities.

The need for nationally coordinated time was recognised last century when railway timetable considerations forced the introduction of telegraph time signals and time zones in large countries such as the USA, Russia and Australia. International coordination was forced by the need to establish longitudes.

The discovery of radio revolutionised time coordination, and the International Association of Geodesy established a central office, the Bureau International de l'Heure, in Paris as early as 1912 to ensure that all time signals were coordinated. The availability of such signals has become part of the "national expectation" in most countries, just as are roads, bridges, railways, telephones and a postal service.

The old VNG HF transmitting antenna array at Lyndhurst, Vic.

In 1962 the Australian PMG's Department established radio station VNG to broadcast time signals and a standard frequency "tone" from Lyndhurst, approximately 37 km south-east of Melbourne.

VNG became the accepted method of transferring time within Australia, South-East Asia, the Pacific region and Antarctica. Since only a simple, cheap radio receiver is required, entire projects and systems were conceived and built on the expectation that this aspect of the national technological infrastructure would be available into the indefinite future. Examples include the geodetic network, the network of seismological observatories, the precise time comparison network, programs of observing pulsars, quasars and lunar occultations, electric power networks and Antarctic research.

Telecom announced in September 1986 that it would be closing VNG. (Telecom's rapid advances in technology had rendered VNG redundant for its own purposes.) The National Standards Commission (NSC), which monitors the National

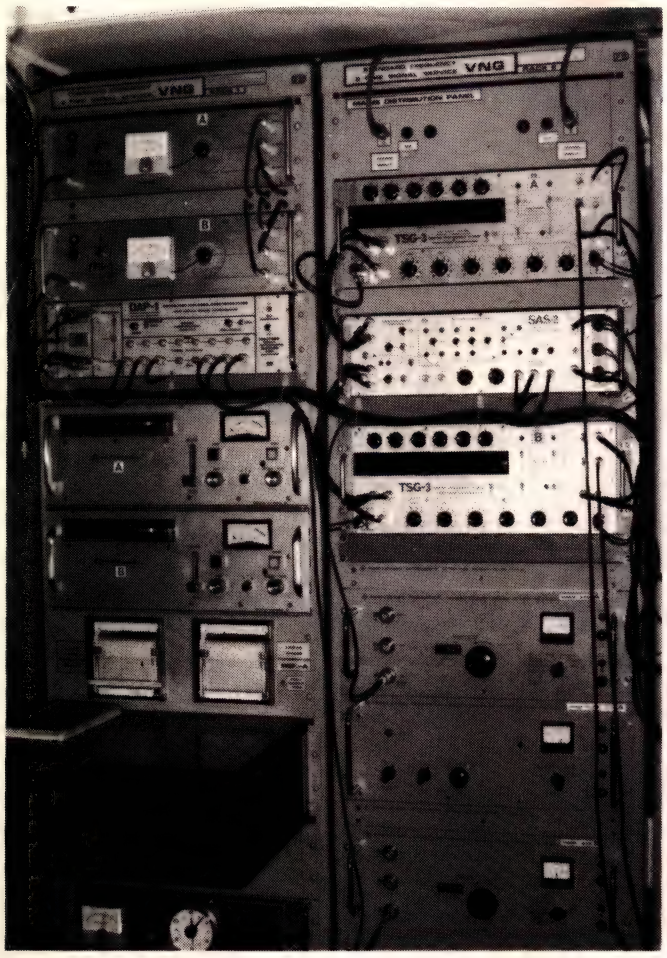
VNG USERS' CONSORTIUM

OBJECTIVE

To re-establish and maintain a national radio standard frequency and time signal service.

TERMS OF REFERENCE

- To obtain the necessary equipment from Telecom.
- To arrange and, if necessary, finance dismantling and packing of the equipment at Lyndhurst.
- To arrange a secure storage area for the equipment, and to transport it thereto.
- In conjunction with the National Standards Commission, to obtain approval from the appropriate authorities to operate the system.
- To negotiate transmitting licences from the Department of Transport and Communications.
- To set up the equipment and prepare for operation.
- To obtain the necessary funds by public subscription and assistance, to enable the above "initial functions" to be performed.
- To negotiate an agreement with the transmitting authority for guaranteed continued operation of the service.
- To obtain the necessary funds by public subscription and assistance, to operate the transmitting system continuously and indefinitely, until such time as complete Government funding is available or until the service is proven to be no longer necessary.



The VNG time and frequency standard equipment.

Measurement System, made representations to Telecom and responsible ministers, and succeeded in delaying the closure until 10 am on 1 October 1987. It conducted a survey of users early in 1987 and found that it was mainly smaller, low-profile organisations and programmes which would be most affected and which had difficulty in quantifying the economic impact of the closure. These users had no alternative but to seek other sources of time standards.

Many alternatives have been studied, including:

- Telecom time signals on land lines; they are not applicable to field work, and are either expensive or inconvenient.
- Foreign radio time signals; they are weak, difficult to interpret and generally unsatisfactory.
- Time signals broadcast from Department of Defence (Navy) in Canberra; they are often weak, are not compatible with normal receivers, are not guaranteed to be "on time", and may not continue after this year.
- Omega broadcasts from Darriman, Victoria; they require special receivers which are not commercially available, the "unique frequency" used may be discontinued, there are ambiguities in interpretation, and it has proved unsatisfactory in several regions tested. Nevertheless, two major organisations have chosen to develop receivers.
- Satellite broadcasts; they require very expensive receivers.
- Restoration of VNG to another site under another authority.

VNG Users' Consortium

A VNG Users' Consortium has been established as a sub-committee of the NSC's Precise Time Working Group, with the objective "to re-establish and maintain a national HF radio standard frequency and time signal service".

It has identified two existing transmitting stations suitable for hosting the service, and is awaiting the necessary approvals. The Consortium is soliciting subscriptions from many sources to relocate the transmitting equipment (which may cost $10 000), and to contribute to recurring costs which are not expected to exceed $40 000 per annum.

Telecom has agreed to donate the equipment to the Commission. Already, sufficient funds to pack the equipment properly have been promised, and some pledges for annual expenditure have been received.

Impact

An example of the impact of VNG's closure comes from the Global Seismograph Network, for which the US Geological Survey has placed equipment valued at $1.5 million in Australia since 1962. The standard of data from some of this equipment is no longer acceptable due to poor timing.

Another example comes from the new 2.3 metre astronomical telescope on Siding Spring Mountain, officially opened by the Prime Minister in 1984. The telescope's very accurate positioning capability was designed around VNG's availability. The productivity of this instrument is severely compromised.

Surveyors are finding that they cannot determine property boundaries correctly in the remoter regions of their operations without VNG.

The Seismology Research Centre, Phillip Institute of Technology, produces and sells seismological recorders and software, eliminating the need to import them, and earning overseas revenue. The cessation of VNG is costing this organisation ten man hours per week of productive output.

Many more examples exist and will arise, especially from those users who only need the service sporadically, and who cannot afford to re-equip, thereby losing business or productivity.

It is therefore imperative that this essential part of the national technological infrastructure be re-instated and maintained. The user community, many of whom "never missed it until it was gone", is demonstrating its preparedness to contribute modestly to its upkeep which, on current indications, will total one cent per taxpayer per year.

It is saddening that even private individuals are being forced to contribute to what some 21 other nations proudly consider to be a public service. Such nations include USA, UK, USSR, Japan, India, Taiwan, Argentina and Venezuela.

It is clearly unsatisfactory in the long term for the group of individuals who currently comprise the Consortium committee to assume responsibility for the integrity and operation of the service.

We recommend that the Minister for Industry, Trade and Commerce and the Minister for Transport and Communications be approached to put the operation of a high frequency radio standard frequency and time signal service on a firm basis as a government function in the national interest, and that adequate appropriation for its continued operation be made in the annual federal budgets.

Contacts

The VNG Users' Consortium can be contacted through:

The Secretary,
Dr Marion Leiba,
26 Fimister Circuit,
Kambah 2902 ACT.
(062)83 2218 (W)
(062)31 9214 (H)

or

The Treasurer,
Dr Gary R Hovey,
Mount Stromlo Observatory,
Private Bag,
Woden 2606 ACT.
(062)88 1111(W)
(062)82 4485(H)

NOVICES! • from page 109.

Is two metres worth it?

Too right! I hope I haven't discouraged anyone with tales of lossy cables, finicky connectors and the like. VHF FM offers opportunities completely impractical on dear old HF (bless its heart!).

There is little to compare with the feeling of security and well-being provided by a little FM transceiver in the backpack, whilst out bushwalking. I am still amazed at the range I could get with a folding quarter wave groundplane on a short length of coax, and the number of repeaters I could access – granted, from pretty lofty locations.

VHF FM is the mobile communications mode *par excellence*. Either by simplex amongst a small local group, or by repeater over a wide region, two metres FM provides an excellent combination of the best features of other bands, with equipment that is reasonably priced, convenient in size and not too critical to install.

Overseas amateurs visiting Australia (and vice versa) will often make their only contacts through hand-held FM rigs, because of their obvious convenience when travelling. Who wants to carry an HF transceiver, power supply, rolled-up wire antenna and SWR meter when travelling? (OK, I used to, but the hand-held takes pride of place now!)

The Yaesu FT-290R is a very popular low-power all-mode rig. Designed for self-contained portable use (with built-in cells and telescopic whip antenna), it can also be used with great success as a mobile rig, with an external antenna and power from the car battery.

Interstate contacts are possible with the most modest of equipment at one end – due to the availability of well-sited repeaters. Canberra stations (albeit with "reasonable" installations at their end) make regular appearances on Sydney repeaters, and thus can be contacted with milliwatt-level equipment.

Each band and each mode of operation has its own staunch adherents and opponents. Two metres is no exception, and I'm certain that it is in the process *right now* of gaining many more delighted converts.

LETTERS • from page 17.

advise you to try and get one of the "tiny" Forth systems available for the C64. Enquire through one of the user groups to find a supplier.

When communicating with the Novix via the serial port, your serial port communications speed should be set at the maximum speed available to you. (With a C64, that's about 2400 bps).

Roger Harrison

Comprehensive PC graphics and video enhancements

Control Systems, represented in Australia by Omnitech Supplies P/L, are promoting an impressive range of graphics, video and image processing cards for the IBM PC/XT/AT and compatible range of computers – plus one for the IBM PS/2.

They are the ARTIST GT series (hi-res graphics for CAD), the ARTIST "illustrator" (digitising for image processing), and the ARTIST Video 2 (for superimposing computer images over video signals).

The GT controller is said to offer *instantaneous* redraw for even the most complicated drawings from within the industry standard AutoCAD software.

The ARTIST 10 and ARTIST 10/16 GT cards have a resolution of 1024 x 768 pixels and 2 Mbytes of display memory, which allows AutoCAD users to display and edit four separate views of their drawing simultaneously. This feature, combined with the unique "bird's-eye-view" window eliminate the need to repeatedly zoom in and out on the drawing.

Control Systems are providing a version of the ARTIST 10/16 for the IBM PS/2 – claimed to be the first third-party graphic controller for the PS/2.

The ARTIST Video 2 enhancement card allows computer text or graphics to be professionally merged with live or recorded video images.

The card features a display resolution of 1024 x 512, with 16 colours from a palette of 4096. A double buffered mode is provided for flicker-free animation, and many popular graphics packages are supported.

The *genlock* feature superimposes the computer display over the video (*keying*), allowing jitter-free sync to a wide variety of sources. Graphics can be previewed, and checked, before broadcast.

The growing image processing market is being addressed by the ARTIST "Illustrator" graphics card, which provides the ability to combine high resolution real-time digitising of video images with computer generated graphics.

256 colours can be displayed simultaneously with a resolution of 1024 x 512 pixels and many popular graphics software packages are supported.

Image processing applications facilitated by the card include: diagnostic medical imaging and transmission of records, industrial inspection and radiography, remote sensing, astronomy applications, motion analysis, robot guidance, and desktop publishing applications.

Enhancements of interest to software developers and OEMs are: bit-plane masking, multiple pixel write, fast screen clear, double buffering, master/slave mode, and a 16 million colour palette.

Input to both of the above video/graphics cards can be from a wide range of sources, such as video cameras, videodisk, VCR or other NTSC or PAL signals. Output can typically be to VCR, broadcast TV, transparency, display monitor, printer, hard disk, modem or other RGB, NTSC or PAL receiving equipment.

Founded in 1976, Control Systems is the largest supplier of high resolution graphic controllers for PC CAD workstations. Contact **Omnitech Supplies P/L, PO Box 85, Camperdown 2050 NSW. (02)517 1144.**

New 386AT system board

Austek Microsystems P/L has released a 20 MHz 386AT cache system-board design and documentation package, for system designers of engineering workstations, network servers and other high-end personal computer systems.

Named the Cobra, the board is described as a full function PC/AT system board. It has been tested for compatibility with most popular PC operating systems, software and hardware. The following packages have been validated for use with the Cobra: DOS 3.3, Microport UNIX, Santa Cruz Xenix, Windows 386, OS/2, Lotus 123, dBASE III, WordStar v4 and AutoCAD.

Features of the Cobra 386AT system board include a 20 MHz 80386 processor; 80387 numeric coprocessor; 32 kbyte cache; write buffer; hidden DRAM refresh; up to 4 Mbyte DRAM (with 256k chips) or up to 16 Mbyte DRAM (with 1M chips); four full-size and four half-size expansion slots.

A complete documentation package for the board is available for existing or potential customers. For further information contact **Rob Potter, Austek Microsystems P/L, Technology Park, Innovation House, The Levels 5095 SA. (08)260 0155.**

New Multitech dealership

Dick Smith Electronics has relinquished its dealership of the top end of the Multitech range of microcomputers in order to concentrate on the smaller PC compatible models.

Until recently, Acer computers were sold in Australia under the Multitech brand exclusively by DSE. In future DSE will market the Acer 500+ and the Acer 710, both high-speed PC compatible models, and Remington P/L will take responsibility for the 80286-based 910 and the 80386-based 1100.

More information may be obtained from **Dick Smith Electronics, (02)888 3200.**

AutoCAD for the Mac

Autodesk Australia has announced the release of AutoCAD Release 10, featuring 3D wireframe construction and surface modelling capabilities.

For the first time with Release 10, AutoCAD is available on Apple's Macintosh II.

AutoCAD established the worldwide standard for 2D computer- aided design, today represented by a 50% market share and over 140 000 users.

Release 10 has been made fully compatible with previous versions, and allows for easy transition from 2D to 3D design.

The new User Coordinate System (UCS) feature helps make 3D design an intuitive process for those familiar with AutoCAD's 2D conventions. With UCS, users can specify a construction plane anywhere in 3D space. Once the plane is defined, all of AutoCAD's existing two dimensional drawing commands can be used without modification.

Dynamic viewing allows the user to rotate a 3D model in real time to any orientation. Designs can be viewed in parallel or perspective projection, a feature especially beneficial to architects.

Release 10 is fully compatible with AutoShade, the full colour shading package which will allows rendering of complex 3D designs.

This latest release of AutoCAD will be available on the Mac II, using the standard Macintosh windowing environment and desk accessories. Standard Mac display, printing and plotting peripherals will be supported. Release 10 for the Mac will be available in the third quarter of 1988.

AutoCAD is also available on the IBM PC/XT/AT and compatibles; the SUN-3/4/386i under UNIX; the Apollo DN3000/4000 under Aegis; and the DEC VAXstation II/RC/GPX and 2000 systems under VMS.

For further information contact **Autodesk Australia, (03)429 9888.**

Philips monitor move

Philips are transferring their entire Monochrome Display Components operations section from the Netherlands to Taiwan, commencing in May.

The transfer, which includes the group's management, production, product development, logistics, and administration, is in response to the need to achieve a more cost effective and flexible supply of monochrome tubes and deflection units to the main manufacturers of monochrome monitors – largely already based in Asia.

The product group, which provides components for the high- end monitor market, includes 9, 12, 14, 15, 17 and 20 inch high resolution tubes. ▷

SPECIAL READER OFFER

A Real Time Clock for your Computer for Under $50?

YOU'RE KIDDING!

This nifty little device resides under an existing EPROM or ROM in you IBM/PC or compatible and adds the convenience of a real time, battery backed clock, cheaply.

Simple to install, just like installing an IC, the Smartwatch does not use up an expansion card slot in your PC, allowing you to use it for other equipment. The device is housed in a standard 28-pin DIP, piggy-back socket, fits under any standard BIOS ROM or other EPROM in the computer and is totally transparent to any other devices. It comes complete with a floppy disk containing installation software,

Full details are available in the February 1988 edition of AEM, giving complete installation and operational details.

OK, IT'S OUR BIRTHDAY, so Energy Control has kindly extended the offer until 31ST AUGUST – but that's DEFINITELY it!

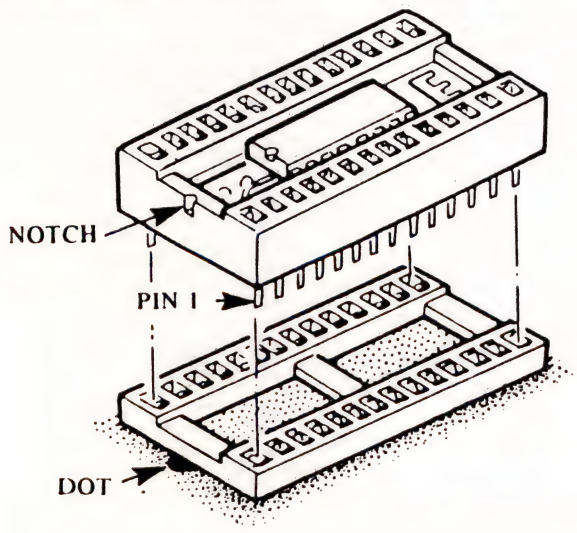
Send mail orders to:

AEM Smartwatch Offer,
1st Floor, 347 Darling St,
BALMAIN 2041 NSW.

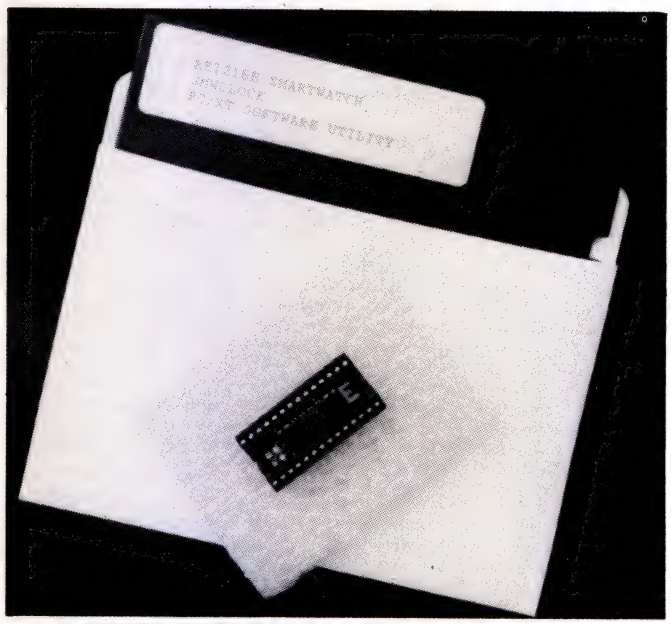
or phone (02)555 1677 and "pledge your plastic".

THE XE1216E SMARTWATCH JUST PLUGS INTO ANY ROM SOCKET ON YOUR MOTHERBOARD. THE ROM PLUGS BACK IN ON TOP OF THE XE1216E MODULE.

(Not suitable for use in compatibles where an RTC is already included on the motherboard. e.g: Amstrad PC1640).



By special arrangement with the importers, Energy Control, we are able to offer readers the opportunity of obtaining this product at a special price as an introductory offer. This offer is made by Energy Control and the magazine is acting as a clearing house for orders.



THE XE1216E "SMARTWATCH" BY XECOM
AS SIMPLE AS INSTALLING AN IC!

PLEDGE YOUR PLASTIC over the phone, or complete the coupon TODAY!

Please send me . . . . XE1216E Smartwatch Module(s) as described in the Feb. '88 edition of AEM.

$49.95 each, plus $8.00 delivery fee. (including sales tax).

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* Make cheques or money orders payable to "AEM Offers Account."

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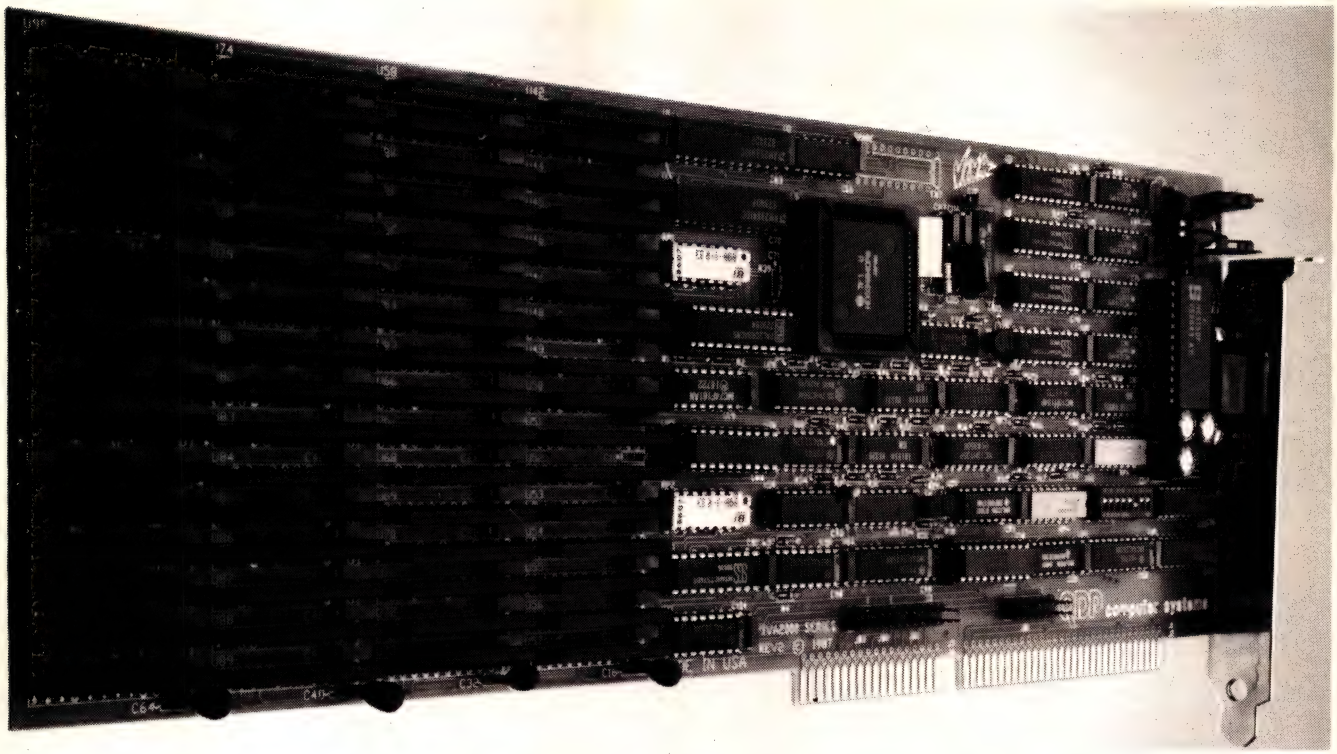
(Orders are despatched to Energy Control within 24 Hours of receipt at AEM).



Ultra-high resolution PC graphics

Kalicom has released the Viva 2000 series graphics board, which is claimed to provide 1280 x 1024 resolution for PC systems.

Features claimed include a fully functional zoom, impressive drawing speed and screen refresh, 2k x 2k *virtual* screen size (displayed at 1280 x 1024), support for all 19" colour graphic workstations, and the ability to be programmed to suit future monitor releases.

Drivers are available for AutoCAD/AutoShade (naturally), Computervision's Personal Designer and CADKEY. Other drivers are being developed.

AutoCAD users are offered instant full view of the drawing for quick orientation, pop-up menus, hardware zoom, pan freeze and user-selectable colours for all elements.

The boards come with up to 2 Mbytes RAM, and provide drawing speeds of up to 50 million pixels/second. They come complete with a five year warranty, and start at $3880 (ex tax) up to $5640 for the 2k x 2k virtual resolution card.

For further information contact **Kalicom, 325 Koornang Rd, Carnegie 3163 Vic. (03)578 0841.**

First Australian Forth Symposium

Even the organisers were surprised at the success of the First Australian Forth Symposium, which was held at the University of Technology, Sydney, late in May.

Initial indications suggested around 100 participants, which was considered fairly healthy for a conference of this nature. Over 200 people actually attended, with a large contingent of overseas visitors, including a couple from Alaska!

The overseas visitors included Charles Moore (who developed Forth), Elizabeth Rather (the second Forth programmer), Rob Reiling (President of Forth Interest Group USA) and Henry Laxen and Michael Perry (the writers of F83 – a public domain version of Forth).

The symposium dinner was attended by over 100 of the participants and the after dinner key-note address by Charles Moore and Elizabeth Rather was both humourous and informative.

Nearly all of the overseas visitors indicated that they will return to the next symposium, which is expected to be hosted in Melbourne in 1989.

A list of participants is being circulated to all of those attending. Any interested persons who were unable to attend the conference and wish to be included on the list should contact **Mr Jose Alfonso, Continuing Education, University of Technology, P.O. Box 123, Broadway 2007 NSW.**

Additional copies of the conference papers are also available from the above address, for $20. In addition, the conference was able to establish a Users' Group for owners of the Maestro Novix Board. The group may be contacted through **Mr Keith Lane, P.O. Box 74, Boronia 3155 Vic.**

The organisers of the conference have expressed thanks to AEM for the support given to the symposium. Roy Hill, AEM's Forth and computing peripherals correspondent, and member of the symposium steering committee, added that "a large amount of editorial space was provided for articles and symposium information and it was support such as this that ensured the outstanding success of the conference".

Mr Rob Reiling assured participants that *no other first-time Forth symposium anywhere in the world*, has attracted such a large number of participants and such a wide variety of papers and application workshops.

Congratulations to all those involved for such a successful venture. No doubt we will hear a great deal more about this lean and efficient language as the circle of users grows.

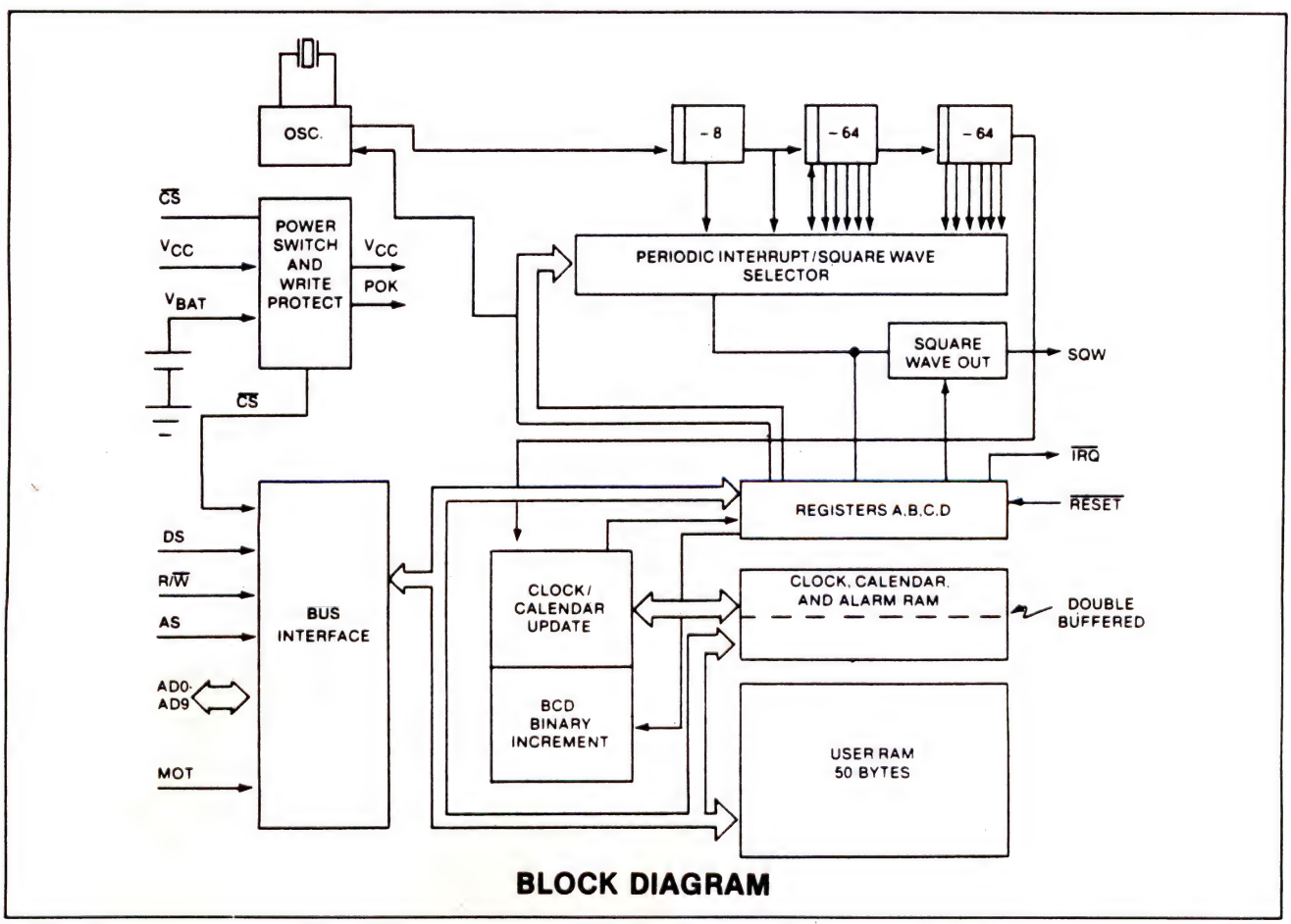
XE1287
RealTime Clock Plus RAM

FEATURES

- ☐ Drop-in replacement for IBM AT computer clock/calendar
- ☐ Pin compatible with the MC146818A
- ☐ Totally nonvolatile with over 10 years of operation in the absence of power
- ☐ Self-contained subsystem includes lithium, quartz and support circuitry
- ☐ Counts seconds, minutes, hours, days, day of the week, date, month and year with leap year compensation
- ☐ Binary of BCD representation of time, calendar and alarm
- ☐ 12- or 24-hour clock with AM and PM in 12-hour mode
- ☐ Daylight Savings Time option
- ☐ Selectable between Motorola and Intel bus timing

DESCRIPTION

The XE1287 RealTime Clock Plus RAM is designed to be a direct replacement for the MC146818. A lithium energy source, quartz crystal and write-protection circuitry are contained within a 24-pin dual in-line package. As such, the XE1287 is a complete subsystem replacing 16 components in a typical application. The functions include a nonvolatile time-of-day clock, an alarm, a one-hundred-year calendar, programmable interrupt, square wave generator, and 50 bytes of nonvolatile static RAM. The RealTime Clock Plus RAM is distinctive in that time-of-day and memory are maintained even in the absence of power.



BLOCK DIAGRAM

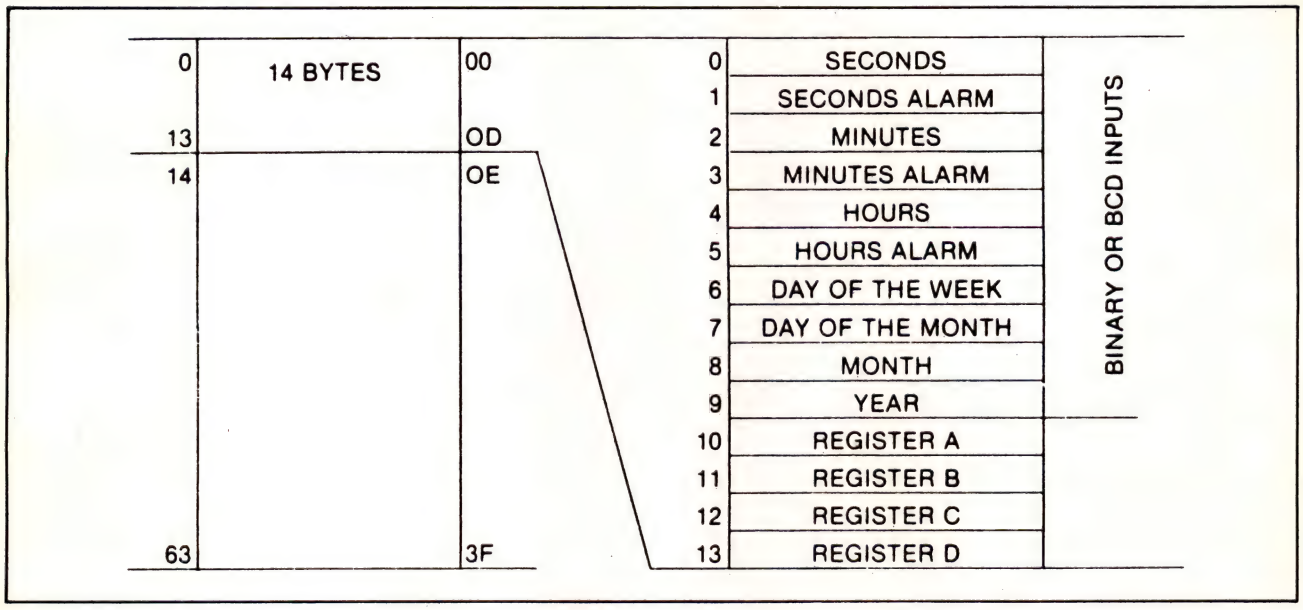
ADDRESS MAP

The address map consists of 50 bytes of user RAM, 10 bytes of RAM which contain the RTC time, calendar and alarm data, and 4 bytes which are used for control and status. All 64 bytes can be directly written or read except for the following:

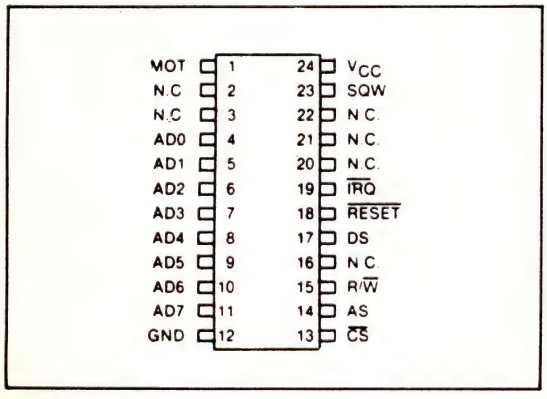
1. Registers C and D are read-only.
2. Bit 7 of Register A is read-only.
3. The high order bit of the seconds byte is read-only.

The contents of four control registers (A, B, C and D) are described in the "Register" section of the complete XE1287 Data Sheet.

ADDRESS MAP XE1287



PIN CONFIGURATION



PIN DESCRIPTION

AD0 - AD7	-	Multiplexed Address/Data Bus
N.C.	-	No Connection
MOT	-	Bus Type Selection
$\overline{CS}$	-	Chip Select
AS	-	Address Strobe
R/$\overline{W}$	-	Read/Write Input
DS	-	Data Strobe
$\overline{RESET}$	-	Reset Input
$\overline{IRQ}$	-	Interrupt Request Output
SQW	-	Square Wave Output
Vcc	-	+5 Volt Supply
GND	-	Ground

Give Your PC AT/Clone Computer the SMARTC

Get the new XE1287 SmaRTC!

Remember the famed SmartWatch? Well, Xecom Inc. in the States has just released the XE1287, real-time clock with RAM.

This nifty little chip is a direct replacement for the MC146818A found in most AT compatible computers. As some AT owners might have encountered, sometimes the Real Time Clock (RTC) and CMOS RAM in their machine mysteriously 'fails' and resets itself. The time, date and the machine's configuration (what type of hard disk, display adaptor you have, etc.), are all wiped!

What a hassle configuring the system every time you turn it on!

So? Is the XE1287 really worth it?

Well, just like its little brother, the SmaRTC has its own miniature lithium power source which will retain the time of day and its 50 bytes of RAM for 10 years in the absence of power. The chip in fact replaces 16 components in a normal installation!

Just like the revolutionary Smartwatch for the PC-XT/Clones, the SmaRTC for the PC-AT/Clones is housed in a piggy-back 24-pin dual in-line package and is as easy to install as an IC! How could you go wrong?

Yes, it really has the SMARTC!

The SmaRTC even compensates for leap years and daylight saving (not applicable in Queensland!). The internal clock can be run in either 12 or 24 hour mode; when in 12 hour mode am or pm indication is shown. Emulation of Intel or Motorola bus timing is also selectable.

JUST $49.95

plus $8.00 delivery

See the Data Sheet in this issue for more details!

To order your XE1287 SmaRTC,

EITHER

Fill in the coupon below and send a cheque or money order to:

AEM SmaRTC Offer,
1st Floor, 347 Darling St
BALMAIN 2041 NSW.

OR

Phone (02)555 1677 and 'pledge your plastic' with Ingrid.

As a bonus for purchasers of the XE1287 SmaRTC, Energy Control will despatch a disk with useful utilities for the SmaRTC and your computer.

This offer is being made by Energy Control International P/L and AEM is acting as a clearing house for orders.

OFFER CLOSES 30 SEPTEMBER 1988.

Yes, please send me . . . . XE1287 SmaRTC's at a cost of $49.95 + $8.00 for delivery.

I am paying by ☐ Cheque ☐ Money Order ☐ B/Card ☐ M/Card ☐ Visa.

Cheque/Money Order No.:_____

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(unsigned credit card orders cannot be accepted)

Name:_____

Address:_____

_____ P/Code:_____

Phone: (____) _____

(Orders are despatched to Energy Control within 24 hrs of receipt at AEM. Please allow up to 10 days for delivery)

A brace of bolt-together ATs

Jamye Harrison

Need an IBM 'compatible' computer, but keen to save money? You can bolt together your own and get the configuration to suit your needs at a price considerably below the 'equivalent' off-the-shelf computer.

I WAS OFFERED the opportunity recently to review a "bolt-together" type AT-compatible computer from Ritronics and, out of the blue and right on its heels, I was offered another from Dick Smith Electronics. I could see I was going to have my hands full! Not to mention my desk. Having been through the bolt-together exercise previously (see the December '86 issue, page 86), and as the techniques covered there apply in large measure to these computers, it seemed unnecessary to reiterate them so I arranged for the systems to arrive ready-assembled.

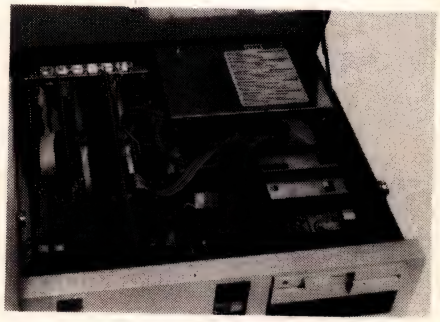
The first to arrive was a 'Baby-AT' from Rod Irving Electronics. This system came with 512K of memory on the 8-slot motherboard (it's expandable to 1 Mb) a 20 Mbyte hard disk, a 1.2 Mbyte floppy disk drive, 84-key keyboard and is speed switchable for 6, 8, 10 and 12 MHz. To give it some real 'grunt', we had an 80287 co-processor installed so we could coincidentally review AutoCAD V.9 and some other software.

A HEGA video graphics card was installed (supports Hercules graphics, CGA and EGA modes), as well as a hard disk controller that can support up to two 1.2M floppies and up to two 20M hard drives. A serial/parallel card was also included, providing one serial and one parallel port, but expandable to provide an extra serial port. Power supply was a 200 W unit. The case measures just 360(w) x 175(h) x 405(d) mm. The DOS supplied was MS-DOS V3.2. The Ritronics system can be purchased as "components" or built up.

The Dick Smith Electronics AT was configured with a 'Baby-AT' 8-slot motherboard with 640K of on-board RAM, a multifunction video card supporting EGA and Hercules, a disk controller that supports up to two 1.2M floppies and two hard drives and an I/O card with one serial, one parallel and one games port. The processor can run at 6, 8, 10 or 12 MHz. DSE supplied MS-DOS V3.3. The case is 430 mm square by 150 mm high.

Both computers, on face value, had similar features. In fact, on closer inspection both had what appeared to be identical motherboards! However, in other aspects, the two computers differ greatly in operation and performance in different fields. For example, both have hardware selectable clock speed changing, but the DSE unit has software speed selection – and a good thing, too, because it "crashed" when I used the hardware switch! The documentation with the Ritronics it makes no mention of software speed switching.

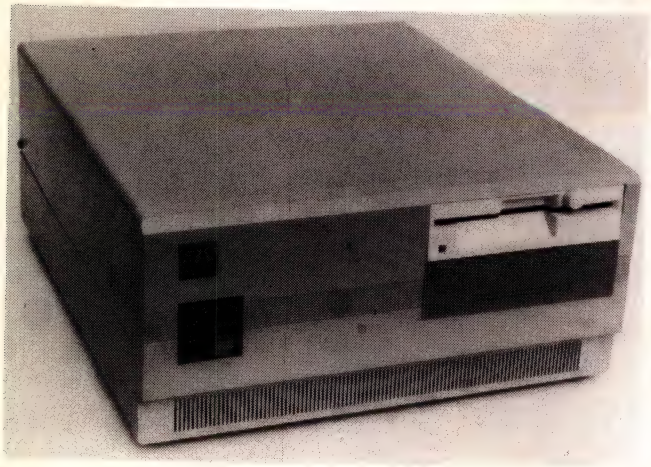
Inside view of the Ritronics machine – "not a lot of room".



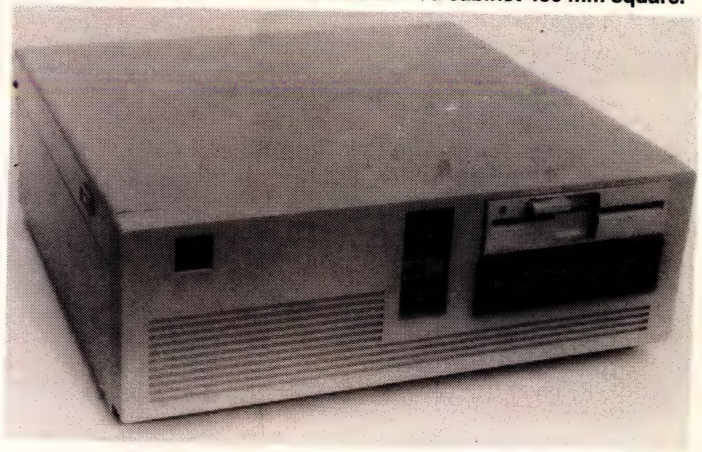
Inside the Dick Smith machine – relatively roomy.

When the computer from Ritronics arrived we immediately put it to good use for our CAD system. As vintage readers will know we use AutoCAD, along with a Houston Instruments plotter to generate the schematics, and many of the diagrams in the magazine. Around Christmas time AutoDesk Australia sent us Release 9.03 of AutoCAD which required a maths co-processor. As the Ritronics AT was supplied to us with an 80287 co-processor we put it to use as a ▷

The Ritronics Baby-AT bolt-together compatible is housed in a box just 360 wide by 405 mm deep.



The DSE AT bolt-together compatible is housed in a cabinet 430 mm square.



The 84-key XT-style keyboard supplied with the Ritronics computer has quite a good action.

temporary CAD station.

I took the computer from Dick Smith Electronics under my wing and used it in the course of my job, writing articles and news item on it, using it with a modem to transfer our setting to the typesetters, plus installing and reviewing software and hardware, on it.

In use

Our CAD system is usually only used by our drafting person, although at times I need to do some work on it for the magazine. Of course the **dramatic** difference in speed was noticed between our ancient IBM-XT and the brand spanking new Turbo-AT with maths co-processor.

The keyboard supplied with the Ritronics AT is better than most I've tried. It has a positive feel, with a distinct, while not overbearing, click (not a clunk). Although being the conventional 84-key, IBM-XT keyboard layout it is perfectly adequate for most day-to-day applications. For many uses an AT-style, 101-key keyboard is overkill, I feel.

On the front of the system unit are two pushbuttons, a momentary type for resetting the system and a push-push type for changing the system clock speed. Operating the push-push type switch was tiresome most of the time. It would have been better to replace it with some other sort of control.

Also on the front face of the box is mounted a key switch for disabling and enabling keyboard input. We have never had cause to use this, although I am sure some people might need it, perhaps to guard against a rampant practical joker? It would be ideal for those whose desk gets cluttered during the course of work, to prevent accidental key presses that might prove problematic.

The Dick Smith Electronics AT proved to be different in operation from the Ritronics clone. It has a larger "footprint" than the Ritronics unit – being 430 mm square as against Ritronics' 365 x 405 mm – but the same controls on the front of the unit. There's not a whole lot of room inside the Ritronics AT, as no doubt you've already perceived.

The Dick Smith AT's larger size enables the installation of another disk drive, floppy or hard. As the storage units are 'filed' in a drawer-like system it is a relatively simple matter to open the case, disconnect the power and data connectors from the drives and remove the "cage" in which they are housed. The hard disk, which occupies the second drawer space, can be moved down to the third space and a second hard disk or floppy drive may be installed in its place. I know, I did it, installing another 5.25" drive I had lying around!

This extra drawer would be useful for installing, say, a 3.5" disk drive as many brands around at the moment are supplied with dummy face plates and connectors so as to physically resemble 5.25" drives.

Each machine exhibited an identical fault. After about one week's operation, the real-time clock in each turned intermittent. The one in the DSE machine failed altogether. The Xecom XE1287 (see pages 118-120) will fix them!

There is a compatibility test, admittedly harsh, that I like try on compatibles – run a few games, like Flight Simulator, Chopper and Round42. I also try AutoCAD. These, all being graphics oriented, prove pretty stringent on the video display requirements, particularly multimode display cards. Whole both machines ran AutoCAD with aplomb, both experienced problems with Chopper and Round42. Everything else I tried, that I could lay my hands on, worked without problems. If you're heavily into graphics-oriented software, it's a point to consider. By the way, both run Michael Delahunty's brilliant Morse/RTTY/FAX software, "RADFAX", without hassles.

Documentation supplied with both computers was, in a word, sparse. You really need to have an electronics/computing background or rely on backup service. Fortunately, the latter is very good from both Ritronics and DSE, with helpful, knowledgeable technical staff on hand. I had reason to use both during on occasion and can vouch for the assistance afforded.

Both machines proved reliable in use (except for the RTC, mentioned earlier), despite changing of cards, addition of extra cards, swapping of disk drives, etc.

Price-wise, the Ritronics AT, as configured, would cost a touch under $4000 at catalogue-listed prices. Ritronics offer a very comprehensive range of expansion cards, drives and other peripherals at keen prices. The DSE AT, as configured, would cost around $3500. A limited variety of expansion cards and peripherals is offered. We're not comparing like-with-like here, and prices yo-yo from month to month, so keep that in mind. Remember, you can arrange the configuration to suit your needs, and your budget.

Summary

Both are worthy of careful consideration. If the footprint matters, your choice is clear – the Ritronics AT. If you need "room to move" inside the case, it's the DSE machine. If you're confident of your own technical ability to handle problems and only require help via a phone call, then other factors must influence your choice. If you need to see before you buy, or require local backup, then geography will doubtless have some influence on your choice. Each is very good in its own right. Whatever influences your choice, I'd say you wouldn't regret it.

Ritronics Baby-AT kindly supplied by Ritronics, PO Box 620, Clayton 316 Vic. (03)543 7877.

Dick Smith Electronics AT supplied by DSE, PO Box 321, North Ryde 2113 NSW. (02)88 3200.

Dick Smith's 101-key AT-style keyboard proved a winner!

AutoSketch – the computer aided pencil and pad

Jamye Harrison

What can you do with a low-cost drafting program, computer and printer or plotter that you can't do with a pencil and pad? Heaps! – as well as similar things, but with a lot more clarity and accuracy.

LAST YEAR, Autodesk released a new software package entitled "AutoSketch", uniquely targeted at the low-volume, first-time, prospective CAD user. AutoSketch, as the name implies, was spawned from the amazingly successful AutoCAD drafting software.

In comparison with AutoCAD, AutoSketch is in the lightweight league for price, size and documentation. However, when it comes to performance and features it is definitely no lightweight.

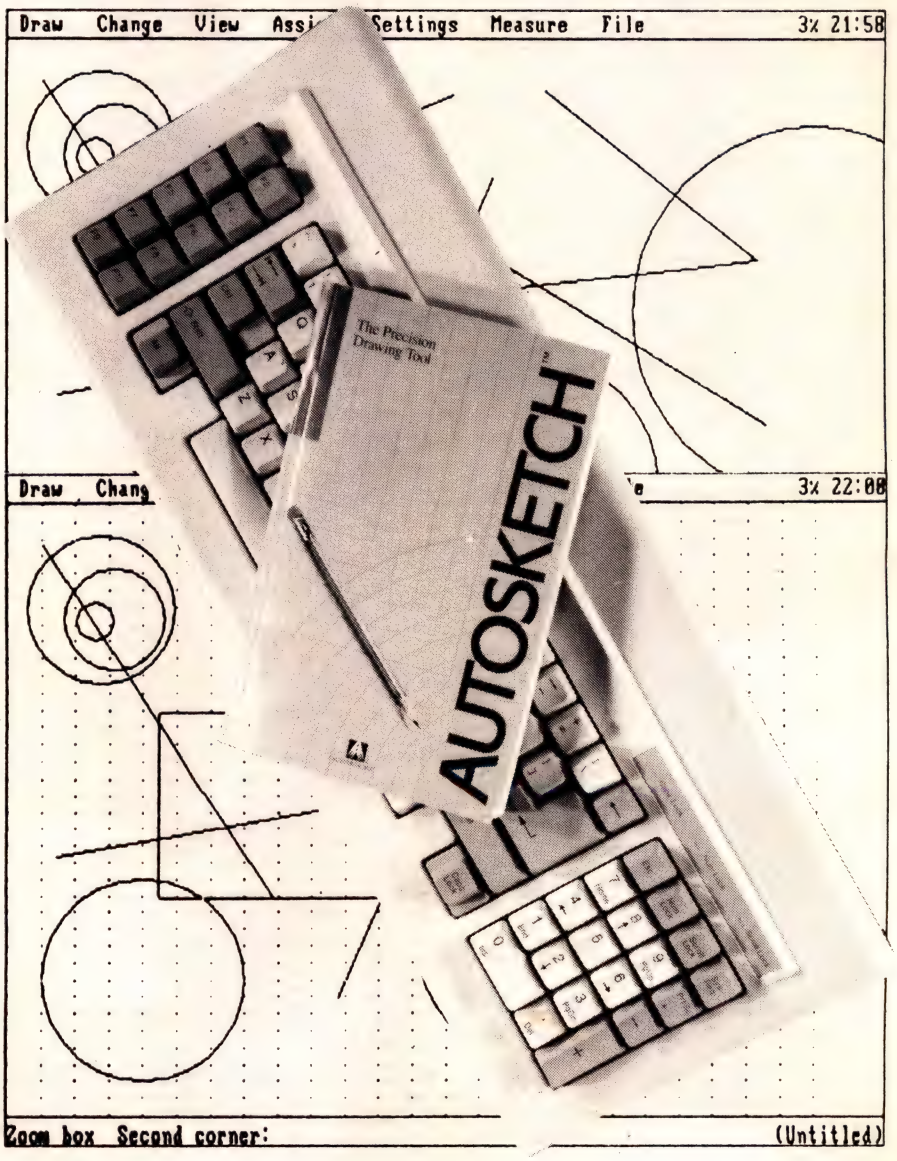
First impressions

On first impressions the program appeared as if it was a mutation of the cluster of PC "painting" programs around (i.e: PC Paint) or a fairly limited, useless CAD package. However, first impressions are not always correct, as proved to be the case here. What I did find in fact was a very useful CAD package but with a PC Paint approach, thus making it easy to implement and use in most current work environments.

AutoSketch requires an IBM PC/XT/AT or compatible, with 512K RAM as a minimum and either two 5.25" floppy drives or one floppy and a hard disk. As for display adaptors, if you have a Hercules Graphics Adaptor (HGA), a Colour Graphics Adaptor (CGA) or an Enhanced Graphics Adaptor (EGA), or close compatible of one of these cards, then you have nothing to worry about.

To "drive" AutoSketch, you can use the keyboard, a joystick, Microsoft's Mouse, a Koala Pad or the Autodesk Device Interface pointer.

Most popular printers are supported including the Epson range, IBM Proprinter, most Texas Instruments models ▷



and some laser printers; the Houston Instruments and Hewlett- Packard ranges of plotters are also supported.

AutoSketch is quite well thought out, showing Autodesk's attention to and experience with the CAD market. If one reads just about any of the CAD performance or usage reports, one of the biggest drawbacks in implementing a CAD system is the time and training it can take to establish the new techniques and procedures.

AutoSketch provides a potential solution to this problem in two ways. Firstly, the software looks and operates more like a PC painting program than a drafting package, being window-driven and featuring operations similar to that of a painting program, while remaining a 'minimal' drafting tool.

Secondly, AutoSketch drawing files can be transported to AutoCAD and manipulated using the extensive drafting commands available to AutoCAD users. This is probably the most useful feature of AutoSketch, and is certainly a big plus for Autodesk as only they are able to execute the same amount of customer support and similar features that AutoCAD users have come to expect and rely upon.

What AutoSketch provides is a single-width "pen", a drawing "tablet" (standard-sized "space" to draw on) and somewhere to store drawings. And you can 'scale' your drawings to a required size. You can create and store away a 'library' of standard drawings – rectangles, coils, resistors, capacitors, ICs, transistors, etc – and call them up and use them in other drawings later.

While you're creating a drawing, you can *zoom* in or out of any part of your work, you can *copy, mirror, rotate, pan* (across a drawing), you can *stretch* (move marked items) things, *break* lines and *attach* lines and drawings accurately together. You can set up fixed grid points which your cursor *snaps* across, and you can vary the spacing of the grid points for a fine or coarse snap to suit your purpose.

The single-width pen might seem a drawback, however if you're using a plotter, the line width obtained depends on the pen used. With multi-pen plotters, AutoSketch will permit pen selection so that you can obtain different line widths. For "fat" lines, as would be used for tracks on a pc board design, you can 'copy' an existing line next to itself a number of times. You can create an oft-used pc board layout "module" and store it for later use in a subsequent design.

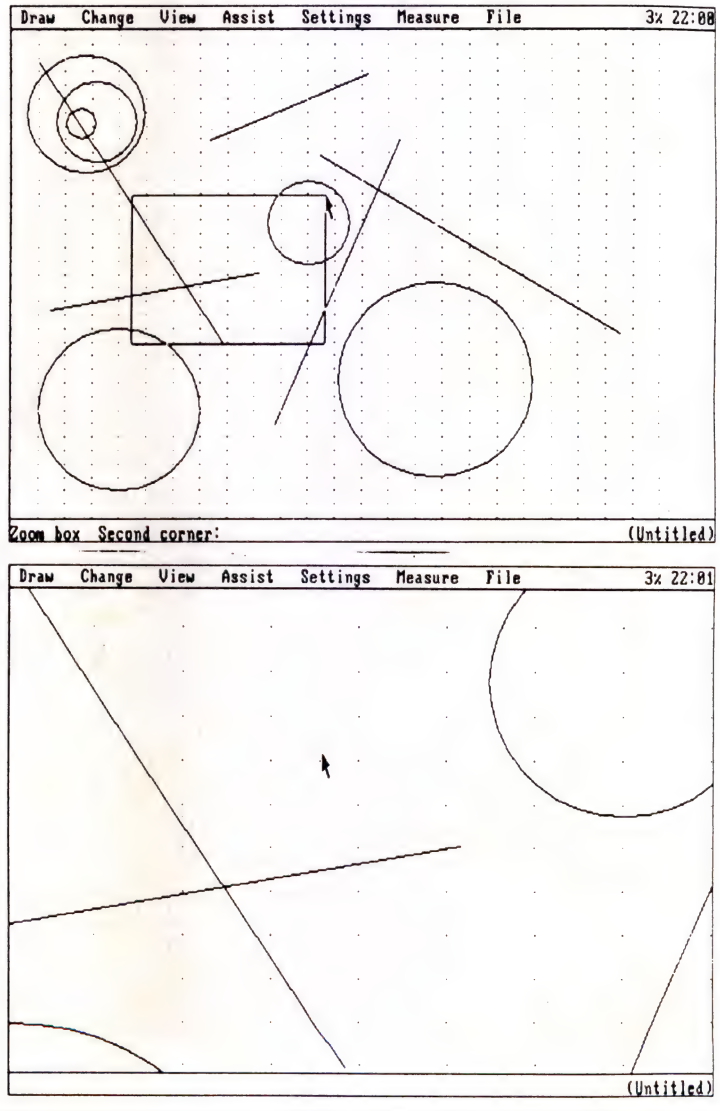
These operations are certainly more cumbersome than is possible with big brother (or is that sister?) AutoCAD, but the trade-off in price and quick learning is worth it. I would say AutoSketch is best suited to common drafting applications, while for pc board layouts you'd be better off with one of the specialised pc design programs.

Changing the View

Let's try working on one area of our drawing in greater detail. Select "Zoom box" from the "View" menu. The prompt *line* becomes:

```
Zoom box   First corner:
```

Enter two opposite corners of a box enclosing the area you want to enlarge. It doesn't matter whether the second point is to the left or the right of the first point. Try a small box that contains some of the objects you've drawn, as shown in the "before/after" figures on the next page.



Other features

From the viewpoint of a PC Paint user, as many PC users will probably have encountered at one time or another (whether it be legally or otherwise), the transition in using the software will lie mainly in getting used to the extra facilities available to you, and the output you can expect from the package.

Probably the best way for me to illustrate the capacity of the product is to highlight some of the more powerful commands and facilities available.

Comparable to the AutoCAD "BLOCK" function is AutoSketch's "PART" command. This allows you to insert, or use, another drawing as part of

their current drawing, enabling you to build up a library of 'parts' which are commonly used, or too complex to be reproduced spontaneously. This function is very useful for drawing schematics of electronic circuitry.

Text may also be used to annotate your drawing. Special provisions have been made to allow you to use the ± tolerance sign and to overscore and underscore text, (very useful when annotating digital integrated circuits).

One of the major differences between the low end painting programs and AutoSketch, is that AutoSketch permits much more flexible shapes to be drawn. For instance the 'CURVE' command allows you to specify where the peak of each curve will lie and then the package will generate a curve, or a series of curves, to 'fit' the set of peaks specified (great for drawing graphs used in illustrating something in an article or documentation).

Measuring of angles and distances is also supported by AutoSketch, something most users would expect to find in CAD software costing many thousands of dollars. You can also measure the X-component or Y-component of an object you've entered. This is especially helpful in engineering and physics related applications.

There are, of course, many more facilities and commands which I could enumerate however, length and brevity don't permit me to do this in this article, and at a price of only $160, how can you go wrong? In a nutshell most of the differences relate to the complexity and treatment of the objects which you create and facilities such as measuring angles and distances.

It would be worth pointing out here that, like AutoCAD, AutoSketch is an object oriented program, i.e: your drawings are treated as separate entities which you create using separate commands. Painting packages, however, only treat your drawings as a set of pixels, assigned a certain colour and position on your screen, (except in the case of text), this is not suited to the CAD user as most, if not all drafting work is object oriented, dissimilar to a 'freehand diagram', a curve here, a line there!

The advantage of being object oriented primarily shows up when zooming-up an object. With paint programs, you get a very rough image. AutoSketch recalculates the figure to produce an image with greater detail.

Overview

What, the overview last? Well, yes; with a package like AutoSketch, having no equivalent product to compare it to I found it necessary to explain the more fundamental concepts first and then the general information about the product as a whole.

The documentation supplied with the software is adequate and well written. It consists of a 60-page handbook which outlines and explains the functions available, taking you through each command with a description and/or an explanation.

Two things which I found the manual lacked was an introduction to the rudimentary aspects of drafting, as opposed to, say, sketching or drawing. Also, many users, especially 'computer virgins', would probably appreciate some step-by-step examples to using some of the more complex commands.

Probably the major overall difference between high end drafting packages and AutoSketch is that AutoSketch does not have the variety of commands and does not support as many types of printers, plotters, pointing devices or display cards. I would not envisage this as being a major drawback though.

Conclusion

For the price, $160, AutoSketch certainly represents value for money when the amount of research and background information that Autodesk has put into their products is considered. The ease of use of the product, especially in relation to its power, is overwhelming. What I think will govern its market acceptance is the amount of imagination people employ in putting it to use.

So, if you are in a small business in need of CAD facilities but cannot afford the thousands of dollars for packages such as AutoCAD or VersaCAD, then AutoSketch is for you. For obtaining quick, clear, accurate drawings that convey the message – and can be bought for "petty cash" – Autodesk's AutoSketch package has no equal.

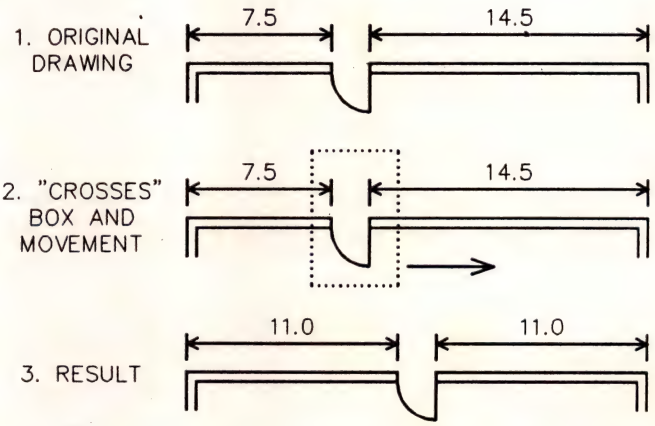
Perhaps you are a computer-owning electronics enthusiast and/or a freelance technical writer and want to employ your computer as a 'tool' for circuit drawing and other drafting work?

Well, your $160 would also be well spent here. It's certainly easier, more versatile, more 'professional' and certainly a lot more fun than using the pencil or pen, compass and set squares of old.

Review software provided by Autodesk, 9 Clifton St, Richmond 3121 Vic. (03)429 9888.

Stretch

This item *forces* a "crosses" type of selection box, and then requests two points, like "Move" and "Copy". Any object that lies entirely within the selection box will be moved, just like the "Move" item. However, if only one end of an object lies inside the selection box, that end moves while the other end remains in place. This is very handy for such operations as sliding windows and doors along the length of a wall, as shown in the following series of figures.



Notice that when a dimension is stretched, its text adapts to the new distance. If the center point of a circle is included in the selection box, the circle moves; otherwise, it is unaffected by stretching. If you stretch one end of a Text object's baseline, the text will compress or expand horizontally and the baseline will rotate accordingly. A Box object can become non-rectangular if you stretch one of its corners.

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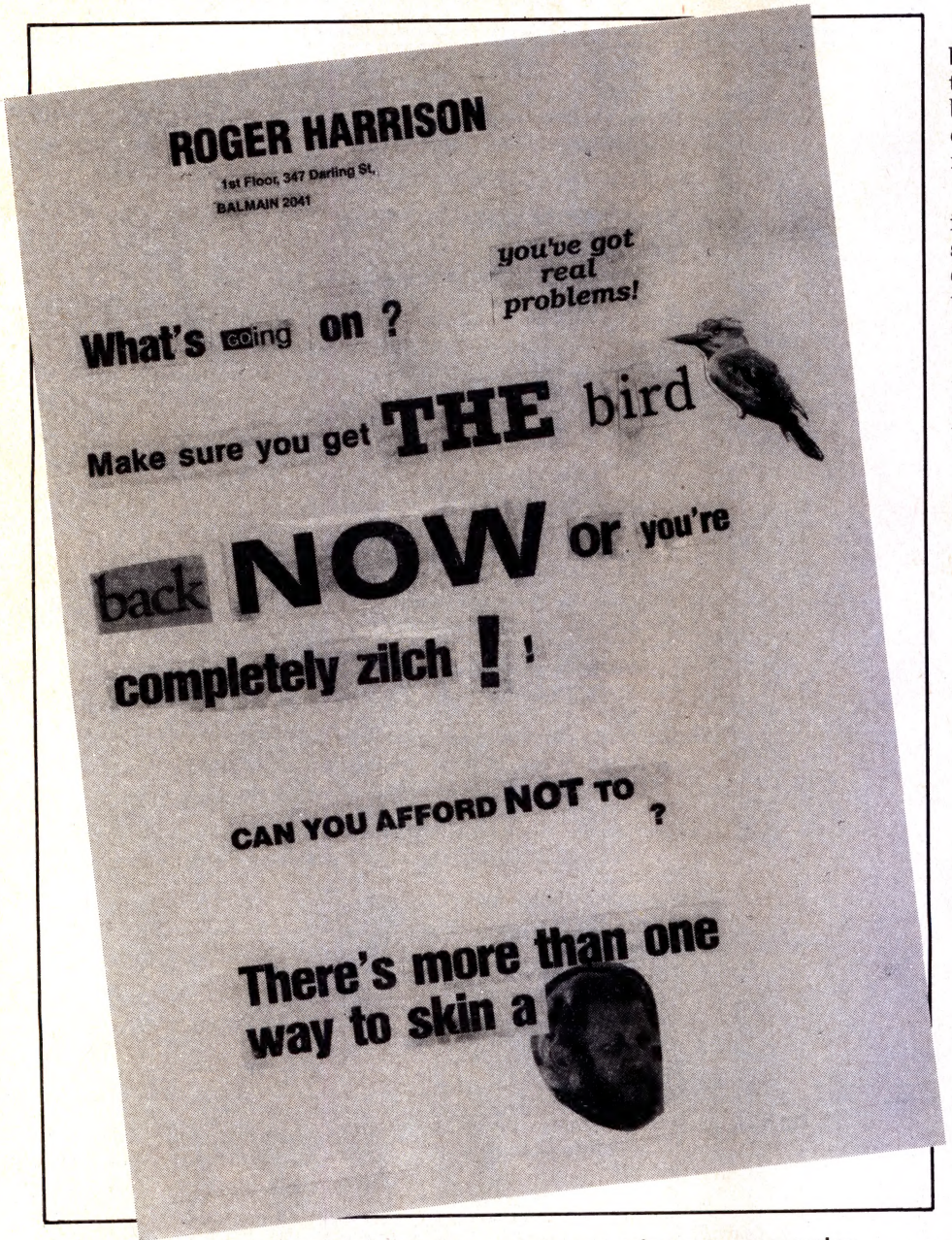

We get a lot of letters at AEM. For the most part, they contain warm, encouraging messages. The occasional letter chides us for some real or imagined error or omission. But the accidental omission of the Kookaburra from the May issue cover unleashed our first threatening letter – which you see here. For the sake of our identity, and our pride, the bird has been restored (see June). We get the message!

THE CASHLESS SOCIETY may have been dealt a crippling blow by a creature whose roots lie beneath the waves of the primordial oceans.

The skin from a *hagfish*, a slimy eel-like fish, is being blamed for demagnetising and scrambling the electronic codes impressed on the magnetic stripes of credit cards and automatic teller cards.

The trail of sinister events and high-tech vandalism starts with craft workers who fabricate the skin into luxury wallets, purses and handbags, much favoured by the smart set in the land of the free, home of the brave.

As reported in *New Scientist* number 1602, thousands of customers have complained to banks in the US that their cards no longer work in automatic teller machines. It is common practice to keep cards in holders made of eelskin.

"It seems to be a major yuppie problem," says John McCosker, director of the Steinhart Aquarium in San Francisco. "Eelskin fashions and the credit card lifestyle may be on a collision course."

The hagfish, *Myxinidae*, also known by the appropriately appealing appellation of the slime eel, may however be the brunt of unfair criticism. There could be other causes of the problem, although no-one knows for sure.

According to McCosker, an ichthyologist who obtained a doctorate studying eels, there are several groups of eels and eel-like fish that are being turned into holders for electronically sensitive plastic cards.

The eelskin products enter the US in huge quantities from South Korea, Japan and Taiwan. It seems anything that is a scaleless fish is being turned into a wallet. They are principally caught for eating, so the skin is a by-product.

Circumstantial evidence maybe? Enough to convict the unfortunate and unattractive dweller of the depths of malicious injury?

Just how could the tanned and processed eelskin affect the contents of the magnetic strip on the cards? A number of hypotheses have been advanced, although none with any real conviction.

The hagfish, "a disgusting creature" according to McCosker, exudes a white viscous slime to ward off predators. If the skin is improperly tanned, the slime may cause a chemical reaction that could damage the cards. But generally the products are of high quality manufacture, and have been well treated.

A number of migratory animals – including eels – contain magnetites in their nervous systems in order to identify the Earth's geomagnetic field. These iron oxide residues could affect the flux of the stripes on the cards, even after tanning.

The explanation lurking in the back of most minds involves the well-known electrical properties of eels, but this too seems unlikely. Keith Morin, who runs a laboratory in Campbell, California, was recently asked by the importers to test samples of eelskin. "I could find no electrical conductivity," he says.

Morin has deduced that the most likely explanation for the problem is the powerful magnet that is used as a clasp on eelskin purses and handbags. "My magnetometer could pick it up 30 feet away," says Morin.

It is, perhaps, a little-known fact now that, before the invention of latex, eel skins – turned inside-out – were used for the same purpose as the modern condom!

THE WORLD WIDE HOBBY!
AMATEUR RADIO
ARE YOU A MEMBER OF THE WIA?

Why not become a radio amateur by joining the Wireless Institute of Australia? The Institute can assist and advise you in how to obtain a Department of Communications licence, which will allow you to communicate with others having similar interests in Australia and throughout the world.

The Wireless Institute of Australia is a non-profit society founded in 1910. Since its inception it has nurtured the interests of all Australian amateurs by liaison at all Governmental levels.

Apart from many other benefits as a member, you receive a monthly plastic encapsulated 64 page magazine called Amateur Radio in your letter box each month.

This magazine contains information on all aspects of the hobby such as Technical Projects, Hints and Kinks, Computer Programs, Free Classified Advertisements and Technical Reviews. Regular columnists give details of Contesting, Awards, DX News, Ionospheric Predictions and Solar Activity, Overseas News and VHF/UHF Activity, to name but a few.

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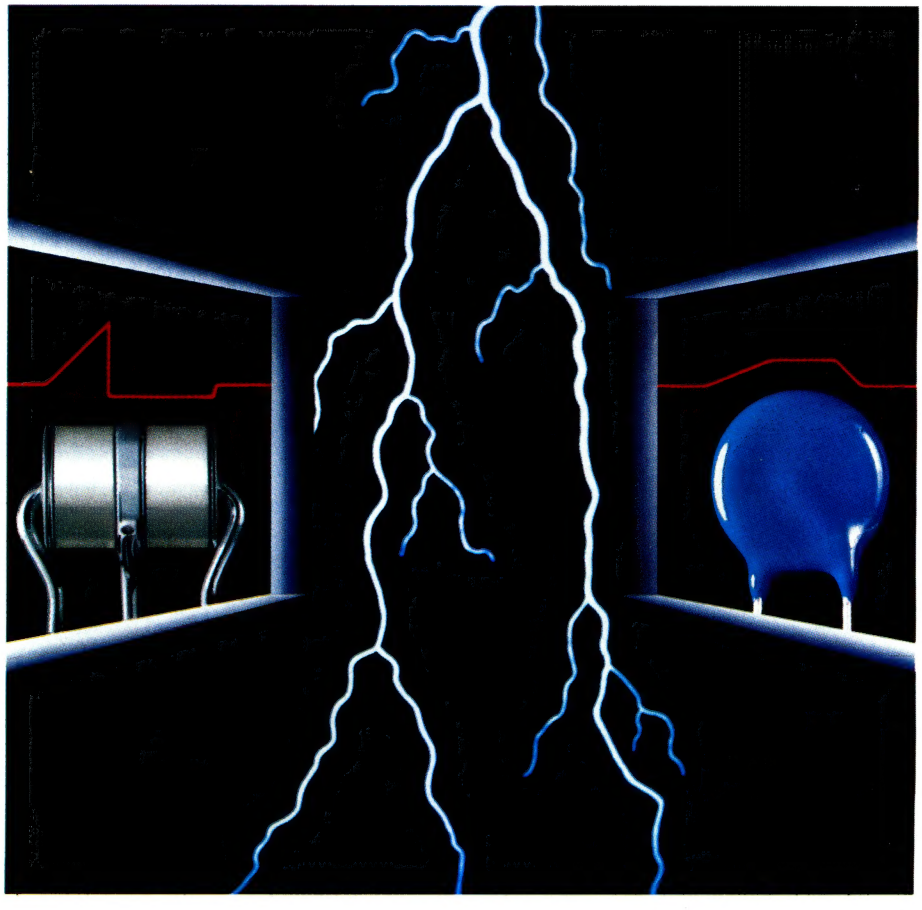

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